ELECTRICAL REVIEW

ILLUSTRATED.

A WEEKLY JOURNAL OF

Electric Light, Power, Telephone, Telegraph and Scientific Progress.

VOL. 20, No. 5. WEEKLY. | NEW YORK, SATURDAY, MARCH 26, 1892. | $3 per Annum. Single Copies, 10 Cents.

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Entered at Post Office, New York, as Mail Matter of the Second Class.

VIEWS, NEWS AND INTERVIEWS.

An esteemed correspondent in the South sends us the following:

"We received to-day a letter from an intelligent party in our vicinity who ordered from us a few days ago a learner's outfit. We quote from this letter literally as follows: 'Our rooms are two up-stairs, or second-story rooms. Now, what we desire to know is, could we safely use boxes of moist dirt for ground wires? Also, what size should the boxes of earth be?' We have with difficulty refrained from advising this party to box in the State and try that."

The Rochester, N. Y., electric circuits have been extended to run sewing machines in houses on the city's edge, and there are hundreds of people who are doing their work for the large clothing firms on the outskirts. The new order of things is gradually coming about.

The enterprising citizens of the famous mushroom mining town of Creede, Colo., which grew to a population of 10,000 in a day almost, now have proposed to the Creede Electric Light Company to suspend an arc light from the summit of the precipitous crag which overhangs Jimtown. The point of rocks from which the light will be suspended is more than 600 feet above the town. In addition to being the highest light in the world and unique in construction, it will light the meandering path from Jimtown to upper Creede.

We have now nothing to fear; what with the Edison electrical hose and the following terrible engine of war, "electrical," of course, the American people can defy the world:

General Serrell, of New York, has recently completed a mysterious invention, by means of which an enemy's ships can be kept outside the harbor, beyond the range of her guns, so that she cannot fire upon the place defended. It is done by electricity and by very simple machinery. The inventor of the device claims that it is applicable to the protection of all the seacoast cities in the United States and Europe. In its application to New York, it is so devised, so the inventor claims, that if a single ship, or fleet of any number of vessels, attempted to enter the harbor, each ship could be struck a blow equal to 50,000 foot tons, and the blow would come from overhead, out of the air, as the ship crossed the six and a half fathom line in the outer bay, 14 miles in a straight line from the City Hall at New York. The blow is to come vertically, and is to strike upon the part of the ship where it will do the most permanent harm. Twenty can be struck in 10 seconds of time. Several army officers and naval experts have investigated the method and say that the blow can certainly be struck within a foot or two of the point intended. General Edward W. Serrell, the inventor of this electrical system of auxiliary harbor defences, was, during the civil war, chief engineer of the department of the South, United States Army; he is the inventor of the hydraulic vertical gun lift, for Barbette guns; he also planned and personally superintended the construction of the world-renowned "Swamp Angel" batteries during General Gilmore's siege of Charleston.

Electric Light Convention Visitors.

In the engraving on this page we present a picture of the passengers on the special train that took the delegates from New York city to the Buffalo Convention on Washington's Birthday. An enterprising photographer from New York city accompanied the party and photographs were taken at Albany, Utica, and at several points in Buffalo.

The picture we present shows the party as they appeared just after having gotten off the train for that purpose at one of the cities while *en route*.

PHOTOGRAPH OF PASSENGERS ON SPECIAL TRAIN TO ELECTRIC LIGHT CONVENTION AT BUFFALO, N. Y., TAKEN AT ALBANY, NEW YORK.

LITERARY.

"Historic Moments" is the title of an important series of brief papers begun in the April *Scribner*. Great events are to be described by eye-witnesses, or important participants in them. Among the subjects already chosen are "The First News Message by Telegraph," "The Last Spike of the Union Pacific," "The Resumption of Specie Payment in the United States" and "The Chicago Fire."

Ex-Postmaster-General James has written an article on "The Ocean Postal Service" for the April *Century*. Mr. James advocates a letter rate of two cents an ounce for ocean postage, and a reduction in the rate on international money orders. He thinks this reform more needed than that of a lower rate of postage on domestic letters.

The Brown & Sharpe Manfacturing Company, of Providence, R. I., has just published a concise and very complete volume on the solution of the problem in gearing met with in ordinary practice, to the exclusion of problems dealing with transmission of power and strength of gearing. The subject is handled in the simplest manner possible and abstruse mathematics are avoided, so that any one familiar with ordinary algebra and elements of trigonometry can have no difficulty in following the reasoning throughout. The book is very neatly bound in cloth, and contains 11 chapters with a total of 60 pages of matter. The clear and simple method employed constitutes the chief attraction of the work.

Execution by Electricity.

We are specially pleased to see that the State authorities in New York are about to reconsider the question of capital punishment by electricity, with a view to the abolition of that form of legalized taking of life. It was, indeed, high time for reconsideration.

Since we last wrote on this subject another "electrocution" scene has occurred, with results even more revolting than any we have previously recorded. Our contemporary, the *New York Medical Record*, has joined its voice with our own in condemning this so-called scientific executioner's work, and has cried "a halt in the revolting experimentation enacted at every execution." "All the victims have been killed, it is true," adds our contemporary, "but how? In every case repeated strokes were necessary, with torturing intervals for discussion and disputation among the scientific experts; the grim tussle with death was timed by stop-watches while the victim was writhing between scorching electrodes. The details of this dreadful business transcend in cool brutality anything that can be imagined, and yet we are assured that this is the new and approved way of doing a victim to death."

These are strong terms, but under the circumstances not one word too strong or too condemnatory. They surely will prevent any further medical participation in these unwholesome deeds. In this country, if medical art were degraded to such participation, the act would not only cause universal indignation against the offenders, but would force the profession at large to raise its powerful and humane voice in repudiation of any and every man in its ranks who dared to take a part in so grave an offence against the national conscience and professional honor.—*London Lancet.*

The right to deposit Thomson-Houston and Edison electric stocks under the consolidation expired Monday. More than 75 per cent. of the Thomson-Houston stocks has been deposited, and it is expected that nearly all will be deposited within a few days. The annual report of the company will not be out until the annual meeting, April 12.

The Heat Radiation of Rarefied Gases Under the Electric Discharge.

Herr Angström, says *Nature*, has been lately engaged in examining with a bolometer the heat radiation of various rarefied gases under the electric discharge. He confined himself to the stronger positive light, using cylindrical glass tubes, with lateral electrodes and rock-salt plates at the ends. An accumulator of 800 Planté elements was the source of electricity. Briefly stated, the results are these: With a given pressure the radiation is proportional to the intensity of the current. With constant current, the radiation does not vary, while the pressure varies between 0.1 and 1.5 mm., but at higher pressures it increases somewhat. With the same gas and pressure, the composition of the radiation is constant, and does not depend on the intensity of the current. With varying density of gas, the ratio of the intensity of radiation of shorter wave lengths to that of the whole decreases with increase of pressure. (This ratio varied, *e. g.*, from 46 to 15 per cent. in carbonic oxide between the above pressure limits.) Thus this ratio, at low pressures, reaches much higher values than in our ordinary light sources. The intensity of total radiation varies considerably in different gases, and stands in no simple relation to the molecular weight, nor to difference of potential in the gas; nor does it seem to depend on absorption of gas at ordinary pressure and temperature.

Vibrations Set Up in a Wire by a Continuous Current.

A fine metallic wire stretched between two supports and traversed by a current will begin to vibrate with increasing amplitude till a maximum is reached, which is maintained as long as the current remains constant and the surrounding air undisturbed; when the wire is enclosed in a tube the vibrations are more regular. The vibrations vary with the current, the size of the wire and its tension, and cease in a few seconds if the current is broken. The author attributes the phenomenon to the heating of the wire.

Ten Years of Electricity.

[*From the Toledo Blade.*]

The ELECTRICAL REVIEW, which is just 10 years old, has in its latest number a record of electrical progress during the last decade. Electric lighting on a commercial scale dates from April, 1882. About 5,000,000 incandescent lamps are now in use in the United States, and arc lighting also has made great progress. The electric lighting of railway trains has become frequent. The first practical electric railway in this country began operations in Cleveland six years ago. Now 250 electric railways are running in the United States, embracing 2,024 miles of track and 3,880 motor cars, with 174,435 horse-power. These railways represent a value of over $49,000,000 in a total of $164,000,000 for all our street railways. The REVIEW states that the average cost per car mile of horse railroads is 5.7, of cable 2.5, of electric 2.2, and of steam 5 cents.

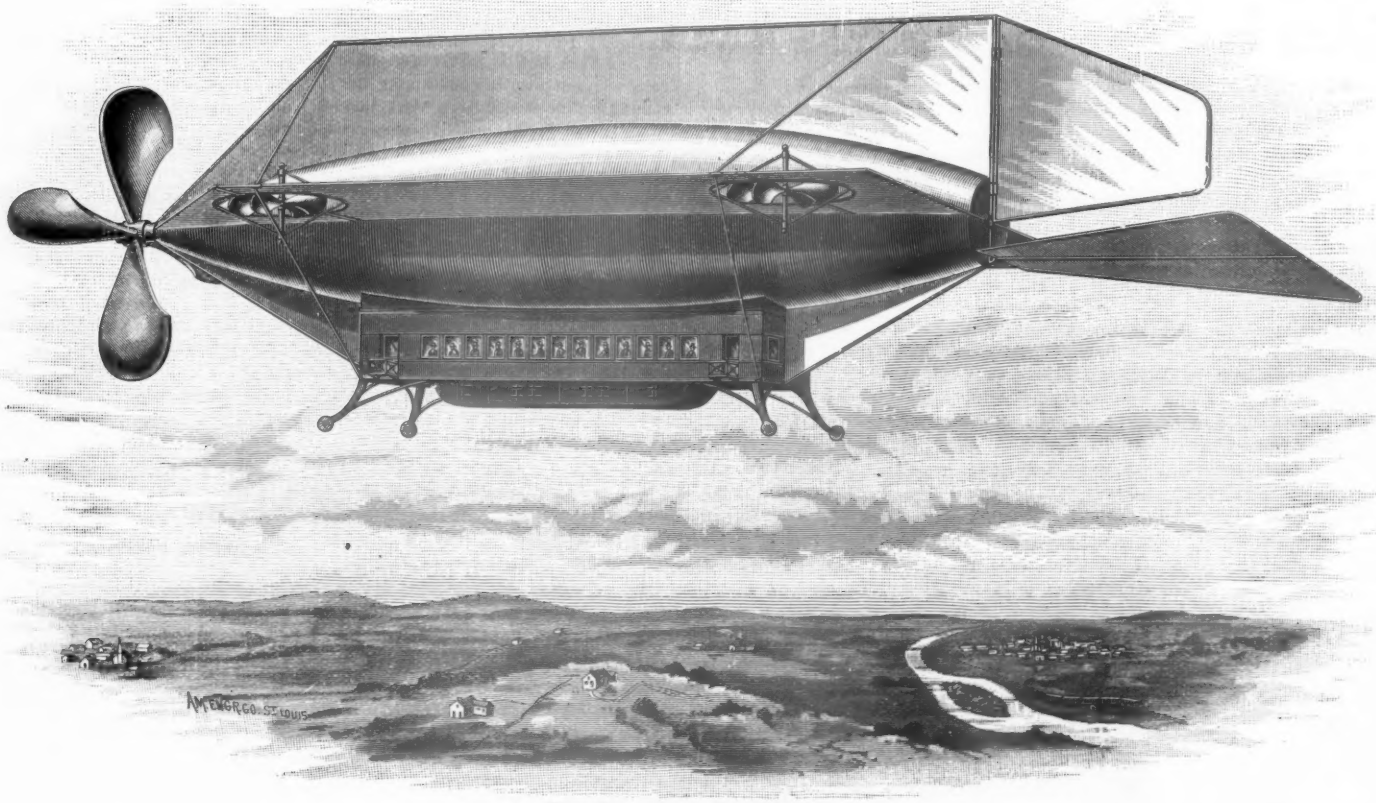
The Mount Carmel Air Ship.

BY E. J. PENNINGTON.

The plant of the Mount Carmel Aeronautic Navigation Company is situated at Mount Carmel, Ill. The main building is shaped after the pattern of a Maltese cross, the crosses being 600 feet in length by 60 feet wide. There are at present employed at the works a large force of mechanics working on the different parts of the aluminum air ship. There can be seen in different stages of completion the numerous patterns from which the aluminum is shaped; large and small forms of propellers lie scattered in seeming confusion, while adjacent is seen the numerous testing appurtenances for speeding the propellers and testing the strength of the tubes and sheets. Another department is used for the construction of the buoyancy chamber, the sheets of which are now being rolled and tempered from the ingot. In another department is placed the gas generating tanks, from which pure hydrogen is supplied to a reservoir which will be used in the aluminum ship when completed. A 100 horse-power engine supplies the main shop with power, while a 30 horse-power does the service for the foundry, blowers and crane. A 40 horse-power engine drives the electric generators. The heating and ventilating apparatus is driven by a 30 horse-power engine, while the hydrogen generators are supplied with a specially designed engine and boiler of 25 horse-power. There is adjoining the main building, in course of erection, a station for the air ship, whence it will issue to make its trips; this building is 300 feet in length by 80 feet high by 75 feet wide. The capacity of the ship will be 50 passengers, and will be able to make a trip from New York to London in 15 hours.

The cut herewith represents a Mount Carmel air ship. The machine is constructed of aluminum, with the exception of the glass which forms the windows in the passenger coach. The large cigar shape form which shows prominently is the buoyancy chamber; this chamber is composed of double thickness of sheet aluminum, a space intervening between the outer and inner sheets which is filled with hydrogen gas. The interior of the chamber is divided into various smaller compartments, the whole chamber being braced with hollow aluminum tubes from its center to its outer surface. In the center of the chamber and extending its full length is a hollow shaft, which forms a part of the chamber and from which radiate the partitions and tubes which divide the compartments; these compartments and tubes being charged with hydrogen gas. A space in the forward end of the chamber is used as an engine room; this is divided from the compartments by a wall or partition. The large propeller at the front of the ship has four hollow blades filled with hydrogen gas. The propeller is keyed direct to the main shaft of the engine, which is hollow and is left open at each end, the air passing through it to the cylinders of the engine which keeps them cool. This propeller is larger in diameter than the buoyancy chamber is at its center. If the buoyancy chamber is 40 feet at its largest diameter, the propeller would be made 42 feet in diameter. This is done so that the currents of air which are taken in front of the propeller are discharged at its outer diameter and deflected aft of the center of the ship, which has the tendency to wedge the ship forward in the direction it is traveling, at the same time allowing the forward end to come in contact with little or no resistance. The top fin, or keel, which extends the full length of the chamber, is made of two thicknesses of sheet aluminum, the intervening space being filled with hydrogen gas. This fin acts similar to a weather vane. When the engine is stopped and the large propeller ceases to revolve, the shape and construction of the vessel are such that when adverse currents and side winds strike it they are deflected from its center, which brings the ship's head to the wind; it is used as a keel on the same principle that a keel is used on a boat, to give the machine steerage. There are two aeroplanes at either side of the vessel; they are made of two thicknesses of sheet aluminum, the same as the top fin. There are two propellers of small diameter on each plane corresponding with one another; they are placed in a horizontal position and when in operation will cause the ship to be raised or lowered, as desired, being reversible. They are operated by gas engines, which are attached direct to the shafts. The vertical rudder at the rear of the ship guides it either to the right or left, and the horizontal or altitude rudder, which is directly underneath the vertical rudder, is used to raise or lower the ship while in motion. The vertical rudder is operated automatically by means of a compass in connection with an electrical appliance. On the tiller of the rudder is attached an electric motor, controlled by the compass and operated by storage batteries. The compass is provided with four posts, in which are placed brushes, set so as to clear the pedestal which supports the needle. When the ship deviates the slightest from its course, either to the right or left, it causes the needle to revolve, thereby bringing the brushes in contact with the pedestal and causing the motor attached to the tiller of the rudder to revolve enough to bring the ship back to its former position, which, at the same time, rights the needle and breaks the circuit to the electric motor. The altitude of the ship is governed by a barometer in connection with an electrical appliance similar to that which operates the horizontal rudder, which allows the ship to conform to the curvature of the earth and to maintain a given altitude while in motion. The passenger coach is made of two thicknesses of sheet aluminum, the intervening spaces being filled with hydrogen gas. The seats and other car furniture are made hollow and filled with gas, as are also the cushions. The operator sits in the interior of the car, at the lower end, and has in view the compass and various switches and other appliances with which he controls the ship. The lighting, heating and ventilating of the car is done by electrical appliances. A space is left between the ceiling of the car and the buoyancy chamber, in which is stored the gas that is used to drive the engines, and underneath the car is placed the storage batteries. The motive power that drives the propellers is furnished by four cylinder gas engines, that will develop one horse-power for every two and a half pounds of their weight. The fuel that is used on these engines can be either coal gas or hydrogen gas, and is fed direct to the cylinders, being mixed with sufficient atmosphere to make it explosive, and is ignited in the cylinders by an electric spark.

When the machine is ready to start, the passengers take their seats in the coach. The ship is always headed to the wind when landed. If the wind should be blowing 10 miles an hour, the large front propeller is controlled to off-set same; the side propellers are then started, having little or nothing to lift. Only a small percentage of power is necessary to raise the machine. When an altitude is obtained sufficient to clear the trees and buildings in the course of the machine, the side or small propeller is stopped. The pilot looks to his chart and sets his compass according to his chart for the desired point; the machine now being handled by its automatic appliances goes direct to its destination, and, upon reaching the same, the large propellers are again stopped. As soon as the machine has attained a speed less than that of the wind, it again points automatically to the current; should it be 15 miles an hour, the large propellers are again started to offset the head current, the side propellers are brought into play and the machine gradually descends to its landing.



THE PENNINGTON AIR SHIP.

American Institute of Electrical Engineers.

The annual meeting for the election of officers, the reception of yearly reports and the transaction of business, will be held at the headquarters of the Institute in New York city, on Tuesday, May 17, followed by a dinner in the evening.

The general meeting for the reading and discussion of professional papers will be held at Chicago on Monday and Tuesday, the 6th and 7th of June. The programme of papers is now in preparation, and full particulars will be given out as soon as possible.

The Sun that Shines for All.

A rather excited appearing man rushed into the depot at Greenwich, Conn., the other evening and startled the station operator with the unexpected information that he wanted to send 1,000 words to the *Sun*, says the New York *Journalist*.

"To the sun!" exclaimed the astonished railroader.

"Yes; can you rush it?"

"Yes, you bet I kin!" answered the operator, recovering his nerve and slinging aside his coat. "You bet I kin rush it!" and he sailed out of the door and grabbed the questioner by the collar. "Only a thousand words, eh?" and he shook him. "You bet; and we've got special facilities for business with Jupiter!" and he banged the victim's head against the door jamb. "Working a duplex with Saturn for two months [thump, thump]! Sending direct to Mars on a copper wire [thwack]! with Venus on the blind side of a repeater [thwack, thwack]! Been receiving Mercury through a pneumatic tube for three weeks [thwack]! and I'd been working with the moon to-night if it wasn't full [bump]! An even thousand words to the sun, eh [bump]! This is the way to settle you cranks!"

"Good Lord!" groaned the man, "stop! its the New York *Sun!*"

"What?"

"The New York *Morning Sun;* a special dispatch!"

"Oh, gosh! I thought you was one o' them dynamiter cranks!"

Electricity for Cooking.

Resistance coils of platinum or German silver wire have been used for experimental cooking. The currents used have been of constant direction, and the coils traversed by the currents must needs be in or in close proximity to the substance to be cooked. Further, the surface exposed by a coil taking taking up considerable room is small, and the amount of heat radiated and conducted from the wire, if not nearly red hot, will not be large. Cooking by electricity has not come into use as yet; the use of alternating currents offers a solution to the problem. A large electro-magnet of great self-induction is constantly in circuit. The loss of current through this coil, as long as metal is not brought near it, is too small to be measured. It being desired to cook flapjacks, an iron spider is placed over the poles of the electro-magnet. The rapid reversals of current in the coil induce currents in the iron spider, which is thereby heated. For heating liquids a copper vessel is preferable, where it can be used, on account of its greater conductivity. The metal in which, or on which, the cooking is done need not touch the magnet. Indeed, a lessened heating effect is obtained by separating the dish from the electro-magnet.

A New Arc Lamp—The "Knowles."

A practically perfect system of electric lighting should be of such a character that any desired kind of lamp, either arc or incandescent, can be run from a single system of wiring, thus obviating the necessity and expense of providing a separate system of conductors for each kind of lamp. At the present time by far the largest portion of

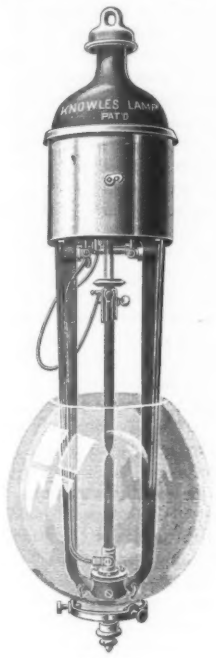


FIG. 1.

all electric lighting is by means of the incandescent lamp.

In a great many instances the best and most satisfactory lighting would be obtained by the use of a much more powerful light, such as the arc lamp, but it has not been practicable until recently to run these lamps successfully on the same circuits with the incandescent lamps. The demand for such a lamp is very great, and a large and profitable field of usefulness is open for a satisfactory lamp of this description. There are now several such lamps in the market working more or less successfully.

An arc lamp for use on incandescent circuits should embody the following features: It should be neat in appearance, compact and of light weight; dust and weather-proof; well ventilated; simple and accurate in construction; perfect in regulation; noiseless in running; non-differential in action (no pumping); perfectly insulated. It should also be capable of burning for at least ten hours with a single pair of carbons and without retrimming; and it should be low in cost.

The "Knowles" arc lamp is practically a universal lamp, working equally well upon a constant current or constant potential circuit or alternating current circuit. It runs at any voltage and any current, and is presented as a radical departure in its construction from all existing types of arc lamps.

Its general construction may be seen in the illustrations, Fig. 1 showing the lamp complete and ready for use, and Fig. 2 showing the lamp with the case removed so that the working mechanism may be seen.

Its length is 40 inches over all and its weight is 20 pounds. It is neat in appearance and compact in construction. There is no projecting horn on the top of the lamp, and no projecting globe holding tube on the bottom, and no unsightly projecting binding posts. It is so designed that it may be hung close up to the ceiling of a room, and its length is such that, even in a low-studded room, it will be clear of the heads of persons passing beneath it, thus obviating the necessity for making holes in the ceiling so that it can be hung high enough up to be out of the way. Its feed movement is very simple and accurate in construction and operation, and not liable to get out of order. The lamp case is dust and weather-proof, and can easily be removed while the lamp is in operation, and the lamp is ventilated in such a manner that any heat generated in the magnet coils is rapidly carried away and dissipated. The dust and weather-proof character of the lamp enables it to be used out of doors without the necessity of its being covered by a protecting hood or canopy. There are only two pieces of insulation in the lamp, and these are of a material which is non-combustible and not affected by moisture. The lamp is non-differential in its character, its feed being positive in its action, and free from all pumping or jiggling. The lamp operates normally at about 50 volts pressure, and at a current of from six and one-half to seven amperes. It will run two in series, on a 110 volt circuit, or as many in series of any circuit as the circuit pressure is a multiple of 50 volts. The lamp will run on any desired current from five to ten amperes, and when once adjusted needs no alteration of adjustment for any variation of current between these limits.

The lamp, when trimmed with a proper size and kind of carbon, will burn at a current of from six and one-half to seven amperes, and at 50 volts pressure, for about 12

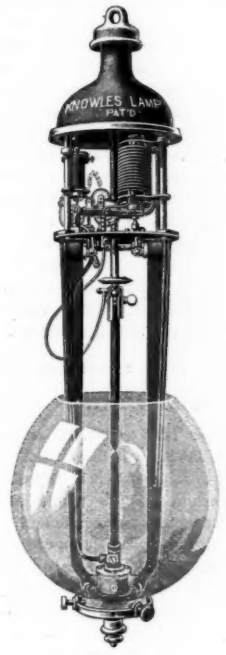


FIG. 2.

hours, thus making it a practical all night single carbon lamp, and doing away with the necessity for a complicated double carbon lamp. The lamp is noiseless in running and gives a pure white, steady light, with no flickering, hissing or sputtering, resembling closely in appearance a very large incandescent lamp.

The diagram, Fig. 3, shows the manner of connecting and arranging the lamps when two are run in series upon a 110 volt circuit. The diagram is the same for other combinations of lamps, as, for example, when four run in series upon a 220 volt circuit, or 10 in series upon a 500 volt circuit, merely substituting the required number of lamps for the two shown.

The lamp is provided with a ceiling hanger board when used indoors, and with a substitute resistance equal to that of the lamp when more than two are run in series upon a constant potential circuit, and with an automatic cut-out when run in series upon a constant current circuit.

This lamp was invented and patented by Edward R. Knowles, chief electrician of the Schuyler Electric Company, of Middletown, Conn., and has been adopted by the Thomson-Houston Electric Company.

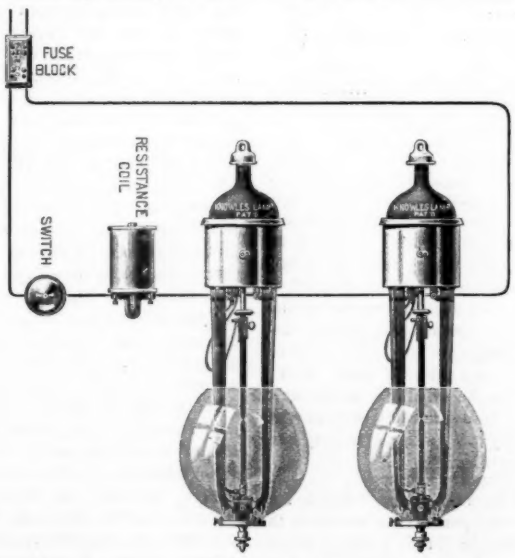


FIG. 3.

Annual Meeting of the Brush Electric Company.

The stockholders of the Brush Electric Company, of Cleveland, Ohio, held their annual meeting at the office of the company in that city, March 15.

Directors for the ensuing year were elected as follows: S. A. Barton, Boston; J. S. Bartlett, Boston; Myron T. Herrick, Cleveland; J. Potter, Cleveland; C. A. Coffin, Boston; William B. Bolton, Cleveland; S. M. Hamill, Cleveland.

Immediately after the stockholders' meeting, the new board of directors met and elected the following officers: S. A. Barton, president, Boston; John S. Bartlett, first vice-president, Boston; C. A. Coffin, second vice-president, Boston; S. M. Hamill, secretary; L. B. Le Vake, assistant secretary; J. Potter, treasurer; A. H. Hough, assistant treasurer; William B. Bolton, general counsel; J. F. Hughes, auditor; S. H. Short, general electrician; F. A. Scheffler, superintendent; C. W. Phipps, assistant superintendent; S. M. Hamill, general manager, all of Cleveland.

Advisory committee: J. Potter, William B. Bolton, S. M. Hamill.

Manufacturing committee: S. H. Short, F. A. Scheffler, S. M. Hamill.

The General Electric Company.

The bill introduced in the New York legislature by Senator Cantor, on the 15th inst., to incorporate the "General Electric Company," with special privileges and powers, including a reduction of the franchise tax, is in the nature of a test measure. It was directly called into existence by the intended consolidation of the interests of the Edison and the Thomson-Houston Electric companies. When offering the bill Senator Cantor stated that the consolidation of these concerns, which, apart from the Westinghouse companies, cover about all the electrical interests of the State, would, in all probability, be followed by an incorporation under the liberal laws of the State of New Jersey unless New York State offered the stockholders something like equal privileges and powers to those they could secure in New Jersey.

The course of the bill will show what the sentiment of the legislature is in regard to the driving of corporations out of this State by stringent incorporation laws and high franchise taxes.

Major Eaton, counsel for the Edison companies, said recently: "Such a bill as this one, if passed, would enable the stockholders of the Edison and Thomson-Houston companies, who are considering consolidation of their interests, to incorporate the consolidated company under the laws of New York instead of going to New Jersey. Of course, corporations will go to the State which is most liberal toward them in the granting of powers and the matter of taxes."

Chicago, Ill.—Columbia Electric Transmission Company; capital, $500,000. Incorporation papers sent to Clarence Griggs, Ottawa, Ill.

Portland, Me.—Pennock Battery Electric Light and Power Company; capital, $1,000,000. Promoters, George W. Moses, Wm. H. Hunt, Samuel P. Tenney, Chelsea, Mass.

Chicago, Ill.—Chicago and Edison Park Electric and Street Railway Company; capital, $500,000. Incorporation papers sent to N. H. Hauchette, 173 La Salle street, Chicago, Ill.

Shawneetown, Ill.—Shawneetown Electric Company; capital, $20,000. Promoters, C. C. Travis, W. M. Richert, Annie J. Travis. Incorporation papers sent to C. C. Travis, Shawneetown, Ill.

Everett, Wash.—Robinson and Moore; capital, $5,000. Promoters, Samuel F. Robinson, Charles P. Moore, of Everett, Wash. Incorporations papers sent to B. S. Grosscup, Tacoma, Wash.

Edgerton, Wis.—Edgerton Electric Light Company; capital, $6,400. Promoters, F. W. Coon, M. Peltin, W. T. Pomeroy. Incorporation papers sent to Edgerton Electric Light Company, Edgerton, Wis.

Ridgway, Pa.—The Ridgway Electric Light Company; capital, $10,000. Promoters, C. M. Jackle, Fred. H. Ely, E. C. Ross, all of Ridgway, Pa. Incorporation papers sent to Fred. H. Ely, Ridgway, Pa.

Holland, Mich.—Wolverine Electric Light Company; capital, $25,000. Promoters, E. W. Richmond, Jas. Huntly, Jno. E. McLane, all of Holland, Mich. Incorporation papers sent to G. J. Diekema, Holland, Mich.

Los Angeles, Cal.—Pemrock Electric Company; capital, $1,000,000. Promoters, John P. Culver, W. W. Robinson, Adolph Erdman, A. C. Taylor, R. R. Haines. Incorporation papers sent to T. H. Ward, Los Angeles, Cal.

Seattle, Wash.—Seattle and Everett Railroad Company; capital, $500,000. Promoters, R. Hilton, John P. Fay, Herman Chapin, all of Seattle, Wash. Incorporation papers sent to R. Hilton, 200 Butler block, Seattle, Wash.

Camden, N. J.—The Electric Launch and Navigation Company; capital, $300,000. Promoters, J. Parker, R. Gibson, Philadelphia, Pa.; J. H. Holloway, Camden, N. J. Incorporation papers sent to H. Weston, 31 Nassau street, New York city.

Charleston, W. Va.—St. Kanawha Falls Water Power Electrical Manufacturing Company; capital, $1,000,000. Promoters, M. Levi, J. C. Alderson, Levi Welch, Charleston, W. Va. Incorporation papers sent to O. A. Patton, Charleston, W. Va.

Bayonne, N. J.—Bayonne City Electric Light and Power Company; capital, $50,000. Promoters, W. H. Peddle, Roseville, N. J.; R. Stewart, E. A. Dugan, Jersey City, N. J.; J. T. Olhausen, Elizabeth, N. J. Incorporation papers sent to Hildreth & Barker, 32 Nassau street, New York city.

The Edison Electric Illuminating Company, of Lancaster, held an adjourned meeting at the office of the company, West Orange street, one day last week. The number of members in the board was decreased from seven to five, and the following were elected: Messrs. John R. Bitner, Benj. P. Miller, John V. Loughney, of Philadelphia; H. S. Williamson and Hon. David McMullen. A number of the old board declined a re-election. The board then organized by electing Mr. John R. Bitner, president; Mr. John C. Carter, treasurer; and Mr. Harry Lively, secretary.

ELECTRICAL REVIEW

Published at 13 Park Row,
P. O. Box 3329. NEW YORK.

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"ELECTVIEW," NEW YORK.

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CHARLES FFRENCH, Editor for Europe.
HOTEL VICTORIA,
Northumberland Ave., Charing Cross, London, W. C.

Cable Address: - - "Electview," London.
Telegraphic Address: Ffrench, "Victoriola," London.

ADVERTISING DEPARTMENT,
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One Year, United States and Canada, - $3.00
One Year, Foreign Countries, - - 5.00
Single Copy, - - - - - - - .10

ANNOUNCEMENT.

Address all communications and make all money orders and checks payable to order of ELECTRICAL REVIEW, P. O. Box 3329, New York.

No attention will be paid to communications for the REVIEW without the *name and address of the writer.*

NEW YORK, MAR. 26, 1892.

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One of the best evidences of progress in the development of electric railways is the fact that very few trolley roads have been reported this winter as being delayed by snow-storms. Although the number of electric railways in operation is greater than ever before, delays are fewer and service is better than at any previous time. This is due not only to the apparatus itself, but to the excellent management which now obtains in nearly every electric railway company in the country.

It has been ascertained that owing to lack of support on the part of the members, the New York Electric Club is running behind in its finances and has accumulated a debt. A moderate assessment has been levied upon the members for the purpose of clearing off this debt and retaining the Electric Club in the representative position it should occupy. We sincerely hope that the members of the New York Electric Club will immediately respond to the reasonable demand made upon them for the proper support of an institution which is of the utmost importance and value to the electrical fraternity.

The electrical business is looking up. There are many evidences of a substantial advance all along the line. We expect to see important improvements and vast investments made in the electrical industry during '92.

In the death of Mr. Charles J. Van Depoele the electrical field loses one of its most valuable workers. He was a pioneer in the invention and development of the electric railway and reciprocating electrical tools. His life was spent in hard work, and as a student and a worker of tremendous capacity and unflagging zeal he had few equals. Although called away in the prime of life, being not quite 46 years of age, Mr. Van Depoele leaves behind him an enduring monument in the form of many tasks accomplished. The ELECTRICAL REVIEW extends to Mr. Van Depoele's family the assurances of its deepest sympathy in their great grief.

The passage by the Massachusetts legislature of the act to permit the use of electricity as motive power on the steam railroads in the State is a very clear indication of the firm belief of railroad men in the adaptability of the electric system of propulsion to suburban and trunk lines in place of steam. It is more than probable that the Old Colony road will shortly undertake preliminary tests, under the supervision of electric railway experts, and, as the problem does not bring in any seriously opposing factor, the solution will, no doubt, be effected much sooner than most are likely to suppose. There is a very promising outlook for electric railways for the coming year.

A NOVEL LIGHTNING ARRESTER.

The paper read by Mr. Alexander Wurts before the Institute of Electrical Engineers, presented in this issue, is highly interesting. The persistent way in which Mr. Wurts pursued his search for an efficient lightning arrester not only produced a crop of interesting inventions, but resulted in the discovery of a peculiar non-arcing property presented by certain metals of the zinc and antimony group. The metals tested were zinc, cadmium, mercury, magnesium, antimony and bismuth. When an alternating current arc is sprung between electrodes formed of these metals over a short air gap it will not be maintained as with electrodes of other metals. Another peculiar property is that when the air gap is a long one the arc will be maintained. Thus, if a 1,000 volt alternating current be arced by priming with tinfoil between two brass (zinc and copper alloy) electrodes separated from one-sixteenth to one-sixty-fourth of an inch, it instantly dwindles to a spark no larger than a pea and is destroyed, but if the same current be arced through one-quarter to two inches air gap the arc will be maintained. The cause of this curious phenomenon is not obvious. Mr. Wurts thinks it likely at the instant an arc is started an oxide of the metal is formed which is immediately volatilized and chokes the air gap with vapor of high resistance. This does not explain why the phenomenon does not occur with a direct current; nor why the zinc still acts although alloyed with copper. The copper vapor is a conductor, but will not preserve the arc when the zinc is present. A drop of mercury rubbed on a copper surface is sufficient to put out an alternating arc. The copper vapor acting as a conductor should maintain the arc. Doubtless, the electrolytic action of the direct current plays a hand in producing the difference of result in direct and alternating circuits. Whatever the cause, the fact is of importance in making possible a simple and efficient lightning arrester. A few rods of brass mounted in a marble frame and forming a rigid structure constitutes the lightning arrester—meeting on all fours, in point of simplicity, with the well known saw-tooth arrester. The invention is another striking illustration of the rule governing all mechanical structures, that progress always leads in the direction of simplicity.

TRANSMISSION OF POWER.

A very interesting and instructive contribution by Prof. Elihu Thomson, on electrical transmission of power, is presented on another page. The flexibility of the three phase alternating system is clearly set forth, and, coming from so able a source, carries with it the weight of authority as well as logic. Such a system commends itself chiefly by reason of the possibility it offers of transmission under high potentials. As the electromotive force at the transmitting end rises the line losses become less, the drop being proportionately lower and the amount of energy transmitted increases. For lighting single phase currents are effective, but when power is to be realized, and especially over distributed territory, some form of polyphase motor is the only instrument now at hand. The reference to conversion of polyphase currents into direct currents is an interesting one which shows how universal the resources of such a system may be made. It would seem that such a result might be attained without using the proposed locally excited field magnet in the motor generator. As the only function of the rotating field magnet is to commutate the currents generated in a low tension secondary winding of the rotary magnetic system, and as the only load would be the friction of the brushes, etc., a simple iron disk would synchronously follow the rotating magnetic field, thus admitting of a structure of the utmost simplicity for returning direct currents from polyphase alternating currents.

Polyphase systems, by reason of the water power transmission in Germany, have become so interlinked, in the minds of the electrical public, with waterfalls, that the possibilities offered of conveying power from stations located at distant points, where coal and buildings are cheap, are lost sight of. The buried pipe line containing conductors surrounded by oil is a suggestion which will be followed with growing interest. The general public, abetted by the lay press, will look with horror upon high voltage on overhead lines.

Professor Thomson's experiments indicate that, so far as insulation is concerned, two inches of oil in a pipe would withstand 500,000 volts. To what extent the static effect would interfere at very high voltage can only be surmised. It was found in the German system that the rate of alternation had to be greatly lowered on account of this, to almost one-half the frequency for which the system had been designed, otherwise the current could not get over the line. An underground or surface system might greatly aggravate this difficulty. It is a question, however, which can only be solved by trial, and is worthy of patient, practical investigation.

NOT DANGEROUS.

The tendency to exaggerate the dangers of electricity has invariably been an accompaniment of its introduction for various commercial and other uses.

We say exaggeration for, when accurate statistics have been forthcoming, it has been found that electricity has not been such a "fell destroyer" as daily press articles have led us to suppose. It was so with electric light currents, and the same old cry has gone up now against the "deadly trolley" of the electric railway. The figures recently published by the city of Boston show how unfair this cry has been and the fact that the trolley is not half so black as it is painted, for in one year the West End electric cars carried 119,000,000 people, which is many more than all the railroad lines in and out of Boston carry. In one year the number of deaths on suburban railways was 20. In the same year five people were killed by horse cars in Boston, and only three as a result of accidents by electric cars.

But the cry will not cease yet. Our contemporaries of the daily press must have something to enlarge upon and electricity is *so mysterious.* If they do not get the matter just right—well, the dear public don't know.

The Seventh Annual Report of the Board of Gas and Electric Light Commissioners of the Commonwealth of Massachusetts contains some interesting statistics.

CORRESPONDENCE.

OUR CINCINNATI LETTER.

The Standard Electrical Works, according to Secretary Lawrence, are enjoying a very brisk Spring trade.

The Thomson-Houston Company is reported as being engaged on a large electrical soldering plant for a manufacturing company of this city.

Suburban Property in this vicinity is beginning to realize the beneficial effects of the numerous electric railways leading out of the city. Values are steadily increasing, as is also the suburban population.

A Large Fly Wheel at the plant of the Cincinnati Electric Light Company, on Broadway, burst one day this week, doing considerable damage, but injuring no one. The lights on a few circuits were shut off temporarily.

Personal.—Inventor Jenney, of Indianapolis, was a recent visitor to the city. Mr. Robb MacKie, the well known consulting electrical engineer of this city, has returned from a week's visit to New York. Mr. E. V. Cherry, president of the Standard Electrical Works, has gone South in pursuit of health. He expects to return to Cincinnati about April 1.

Capt. Geo. N. Stone, general manager of the telephone exchange in this city, has extensive plans prepared for new underground work as soon as Spring weather sets in. Work on the new telephone building on Vine street, near Fourth, will begin very shortly. All the contracts for construction work have been signed and the weather is now the only cause of delay.

The Crane & Breed Manufacturing Company, makers of burial caskets and undertakers' supplies, are installing an electric power plant in their manufactory. This is one of the largest concerns of its kind in the country, employing about 400 hands and using considerable light machinery. Supt. W. D. Breed says that, owing to the peculiar disposition of the shafting in this factory and the number of small pieces of machinery used, electric power is better adapted to the service and more economical than steam. Mr. Breed would like to have manufacturers of electric soldering irons communicate with him, as his company has need of such devices.

Electrocution.—A bill is being prepared for introduction in the Ohio Senate which provides for the execution of criminals by electricity. It is patterned after the bill introduced some years ago by Senator Rannells, who now holds an important position in the Department of Justice at Washington. The legislature concluded to wait for the results of the law which was passed by New York, providing for electrocution, "and now that it has been demonstrated that the thing is a success in every way," there is no longer reason why Ohio should not adopt it. The bill calls for privacy in the matter of execution. None are to be admitted but necessary officials and a few representatives of the press. As a precaution against theatrical funerals, it is provided that the bodies of executed criminals shall be buried in quicklime and that no grave-stones be placed to mark the place of interment. All executions shall take place in the penitentiary. S. L. C.

Cincinnati, March 19.

OUR CHICAGO LETTER.

President J. M. Clark, of the Windsor, Sandwich and Amherstburg Electric Railway Company, Windsor, Ontario, is in the city this week.

A. H. Kinney, formerly with the Omaha Consolidated Electric Company, is now located in Chicago with Mr. L. E. Myers, of the Detroit Electrical Works.

The Rockford Electric Manufacturing Company, Rockford, Ill., have just opened a Chicago office at 451 The Rookery, and will be represented here by Mr. F. E. Drake.

The Hall Signal Company's contract with the Chicago and Northwestern Railroad calls for 227 miles of rubber wire to be laid underground, and Simplex braided rubber has been selected for this purpose. This makes another of the million feet orders with which George Cutter is getting familiar.

Thomas G. Grier has returned from Philadelphia. While there he renewed his business arrangements as Western representative for H. T. Paiste. Mr. Grier has removed his office to Room 427, Rookery, where he will carry a full line of Paiste china switches and other appliances manufactured by this house.

A New Company, to be known as the Diamond Electric Manufacturing Company, has just been organized in Peoria, Ill., by Gustave A. Scheeffer and Wm. E. Francis. Their factory has been equipped with the latest machinery for doing all kinds of electrical work. With Mr. Scheeffer's experience, the undertaking should meet with success.

The Athens, Ga., Railway Company, whose lines are equipped with the Detroit Electrical Works' system, report that the service has been excellent, and has given satisfaction from an economical point. General Manager Voss, of the Athens company, says: "We have had very little trouble or expense with the bevel gear, in fact, there is no trouble with it when the friction collars are kept well adjusted, which is very simple and easily done. I have been in the street railway business 12 years, and last year, before we began to make any change in our line here, I made a tour of inspection of the different systems, and I must say that our cars run smoother and make less noise than those of any other system that I ever inspected. M. J. B.

Chicago, March 19.

OUR SAN FRANCISCO LETTER.

The Central Milling Company, of Paso Robles, Cal., have lately installed a 500 light incandescent plant.

A Number of Public Lectures will be given under the auspices of the California Electrical Society in the near future.

An Incandescent Plant has recently been installed at Santa Barbara by the Santa Barbara Gas and Electric Light Company.

Visalia will hold an election shortly to ascertain if the citizens desire to issue bonds for a city electric lighting plant. Two companies have already submitted proposals for the plant.

The Navy Department will make another line of soundings before any definite conclusion is reached relative to the route for the submarine cable between San Francisco and the Hawaiian Islands. The steamer "Albatross" will probably again be sent to make the soundings.

At the Recent Citrus Fair, held in Los Angeles, electric lighting played an important part. Scattered amongst the profusion of oranges, lemons and other California products, were innumerable incandescent lamps. In the evenings, when these cast forth their brilliancy, together with numerous arc lights, there was presented a spectacle of beauty long to be remembered by those in attendance.

An Electric Light War of quite a novel character is now raging on Kearney street, this city, between three rival clothing houses situated within a radius of one block. Each firm strives to make its respective show windows more attractive than those of its rivals, and for this purpose make use of incandescent lights. In consequence, pedestrians are treated to a brilliant electrical display each evening. Two of the above mentioned firms, located directly opposite one another, have gone so far as to burn the lamps during the entire day, as well as evening. J. R. K.

San Francisco, Cal., March 12.

OUR BOSTON LETTER.

The New England Telephone Company proposes putting its telephone wires in Lowell, Mass., underground.

The Hotel Reynolds, Washington street, Boston, will put in an 800 or 900 isolated electric light plant to furnish its own illumination.

The Electric Light and Power Company of Abington and Rockland, Mass., will add to its present equipment a 2,000 light alternating current.

Mr. Robert M. Huston, of the Hine Safety Boiler Company's New York agency, was a welcome visitor among his Boston friends during the past week.

The Maddox Wire Belting Company, of Westbrook, Me., has leased the factory building of J. K. Graham, and will remove its plant to Quincy, Mass.

Saturday Half-Holiday—April 9 to October 29—is being petitioned for by the employés at the Lynn, Mass., factories of the Thomson-Houston Electric Company.

Boston, March 19. W. I. B.

Death of Charles J. Van Depoele.

THE EMINENT INVENTOR PASSES AWAY AT LYNN, MASS., AFTER A LINGERING ILLNESS.

Charles J. Van Depoele, the eminent electrician and able inventor, died at his home, at Lynn, Mass., in the afternoon of March 18. The immediate cause of his death was measles, which attacked him while recovering from the grip, with which he was stricken last November. In his weakened condition, Mr. Van Depoele was unable to throw off the disease and finally succumbed. He leaves a wife and four children at Lynn and his mother in Chicago.

Mr. Van Depoele was well known in electrical circles in Detroit, Chicago, Boston, Lynn and New York, where he has been at different times engaged in his profession. His fame as an inventor was world-wide. The accompanying portrait, which is an excellent likeness, is reproduced from the last photograph for which Mr. Van Depoele sat.

The funeral services were held on Monday morning, March 21 at nine o'clock, in St. Mary's Roman Catholic Church, Lynn. Solemn high requiem mass was celebrated, Mgr. Strain officiating.

CHARLES J. VAN DEPOELE.

Charles J. Van Depoele was born in Lichtervelde, Belgium, April 27, 1846. His father was an engineer on a small railway, and it was here that young Van Depoele gained his first mechanical ideas and, later, learned his first lesson in electricity. When but a boy the first telegraph line in that country was put through near his birthplace, and from watching the operations he became much interested. With what little money he could get by running errands and doing odd jobs for the neighbors he bought himself a couple of battery cells and some instruments, and from that time was constantly experimenting. At one time he had a battery of over 100 cells, which, owing to the opposition of his father, who looked upon electricity as nonsense, he was compelled to hide in a loft in the house in which he lived, and there, on his father moving to another place, they were left. He continued his experiments, spending every spare moment he had in that way, and every cent that he could get went to buy apparatus.

When about 15 or 16 years of age his father apprenticed him to a church furniture and fancy wood carver in Paris, where he soon became master of the trade, devoting his evenings and oftentimes sitting up until daylight experimenting. He continued in this business until, in 1871, he came to this country and settled in Detroit, Mich., where he started a shop of his own, being at the head of 200 hands at one time.

His father, who had followed him here, and his many friends objected to his persistent experimenting and wasting of money, as they were pleased to call it, and met to have him sign papers agreeing to give up his experiments altogether. The meeting had just an opposite effect, and young Van Depoele swore that from that time on he would devote the whole of his time and money to the study of electricity. Accordingly, he placed his father at the head of his shop and, building a little place of his own near his residence, worked altogether at developing his ideas. Becoming interested in the electric light about that time, he constructed a dynamo, and in 1880, after moving to Chicago, formed the Van Depoele Electric Light Company, with A. K. Stiles at its head. The following Summer he lighted some of the streets in Chicago gratis, and soon the company made and carried out numerous contracts.

As soon as this company was fairly started he began advocating the idea of running railways by electricity, contrary to Mr. Stiles' wishes, who thought nothing would come of it. Van Depoele was undaunted, and in 1883 he obtained Mr. Stiles' consent to put up a short exhibition railway in Chicago. Seeing the success of this, Mr. Stiles became enthusiastic, and from that time on offered no opposition.

In 1884 he constructed a conduit road at the Toronto (Ont.) Exposition, followed in 1885 by the overhead system in the same place.

During the next three years he was busy developing the electric railway, taking out many patents and building several railways in Toronto, Ont., South Bend, Ind., Minneapolis, Minn., and other places. In 1888 the Thomson-Houston Company, of Lynn, observing the success of his railway, bought out all of his railway patents, and in March of that year he came on to Lynn and has been connected with the company ever since as electrician and inventor.

It was also by his untiring efforts that the electric percussion drill was brought to its present state of perfection, he having begun his experiments in that field as far back as 1882. Thinking that electricity could be used in the exploitation of mines, he talked with Mr. Stiles about the matter. Mr. Stiles immediately offered him money to carry on experiments, and he soon evolved a drill. Two were manufactured by the Thorn Wire Hedge Company, of Chicago, and experimented with in the company's shops. They were powerful enough to knock to pieces some very large stones on which they were used. Much encouraged, he continued his work, taking out numbers of patents and developing and improving the machines, until now the result of his exertions is seen in the mining drills, pumps, hoists, etc., of the Thomson-Van Depoele Electric Mining Company, whose patents were lately bought out by the Thomson-Houston Electric Company.

Though much interested in all branches of electricity, it is the electric railway and electrical reciprocating devices that owe most to him. At the time of his death he was developing and improving his apparatus in the latter field.

PERSONAL.

Dr. Cyrus Omen Baker, Jr., the well known platinum refiner, is honoring Chicago and the West with his presence this week.

Mr. D. B. Dean, of the McGuire Manufacturing Company, Chicago, is visiting New York, with headquarters at the Hotel Imperial.

Col. George L. Beetle, of Chicago, renewed old friendship for 24 hours in New York city last week. The colonel is looking well, and his many years of electrical work have not subdued his spirits or changed his fine looks.

Treasurer Frisbie and General Agent Hungerford, of the widely known wire manufacturing house of Benedict & Burnham, Waterbury, Conn., were visitors to the metropolis last week. The demand for the new weather-proof "Benedict" wire in electrical circles is one of the things that make these gentlemen happy.

Opinion of an Early Acquaintance.

MR. CHAS. A. BROWN, CHICAGO.

TO THE EDITOR OF ELECTRICAL REVIEW:

I have only just had time to peruse your Decennial Number of the ELECTRICAL REVIEW, and, although I may be late in doing so, I desire to express my appreciation of the excellence of this number and of the REVIEW in general.

I remember well when the ELECTRICAL REVIEW was started, and am tolerably familiar with all the work that has been done in connection with that paper from that time to the present, for I have always watched its progress with interest and pleasure. Please accept my congratulations and best wishes for your continued prosperity.

Yours very truly,

CHARLES A. BROWN.

Chicago, March 17.

New York Electrical Society.

The New York Electrical Society will hold a meeting at Professor Chandler's room, Columbia College, on Friday, March 25, at 8 P. M., when Prof. F. B. Crocker will lecture on "Electrical Measuring Instruments. The lecture will include the demonstration of the most important points in the construction and application of the principal electrical instruments now in use.

Telephonic News

⁂ Manager Gentry, of the Telephone Exchange, Atlanta, Ga., is preparing to begin the work of laying conduits for the telephone wires at once.

⁂ It is stated that the Ohio Valley Telephone Company will soon commence the erection of a line to Mooresville, Ind., to be ultimately extended to Galena and Greenville.

⁂ Jones—What has made the telephone so successful, do you imagine?

Brown—I presume it is owing to the fact that it is run on sound principles.—*Detroit Free Press.*

⁂ On the first of March a mortgage was executed by the Southern New England Telephone Company to the Union Trust Company, of New Haven, as trustee, to secure an issue of bonds by the telephone company of $500,000. The bonds are 400 of $1,000 and 200 of $500 each, payable March 1, 1912, and redeemable after five years, bearing five per cent. interest. The mortgage covers all lines, appliances, privileges, rights, contracts and licenses of the company and the real estate in Hartford, New Haven and Bridgeport. The previous mortgage of $300,000 by the company to the same concern, executed March 1, 1891, is to be protected by the deposit of $300,000 bonds at the face value with the Union Trust Company, so that the amount of the indebtedness secured by this and the preceding mortgage shall not exceed $500,000.

The Telephone in a Fight.

Particulars of the behavior of the field telephone system in the French Autumn manœuvres have now been published. Magnetic telephones were used, as no delicate microphone or battery is required with them. The transmitter was held in the hand and the receiver was affixed to the "kepi." Combined receivers and transmitters were also employed. A bare bimetallic wire, 0.6 millimetres in diameter, was unrolled from a drum and laid out of harm's way on hedges, branches, walls and in trenches. A line 23 kilometres long was thus laid, with the addition of ten posts, in five hours; speech was good, and the whole was taken up again in an hour. During a sham fight a cavalry division passed over a long line without interrupting the communication. A bayonet stuck in the ground made a good earth, so did the body of a cavalry horse if the wire was attached to the bridle.

An Immense Telephone Submarine Cable.

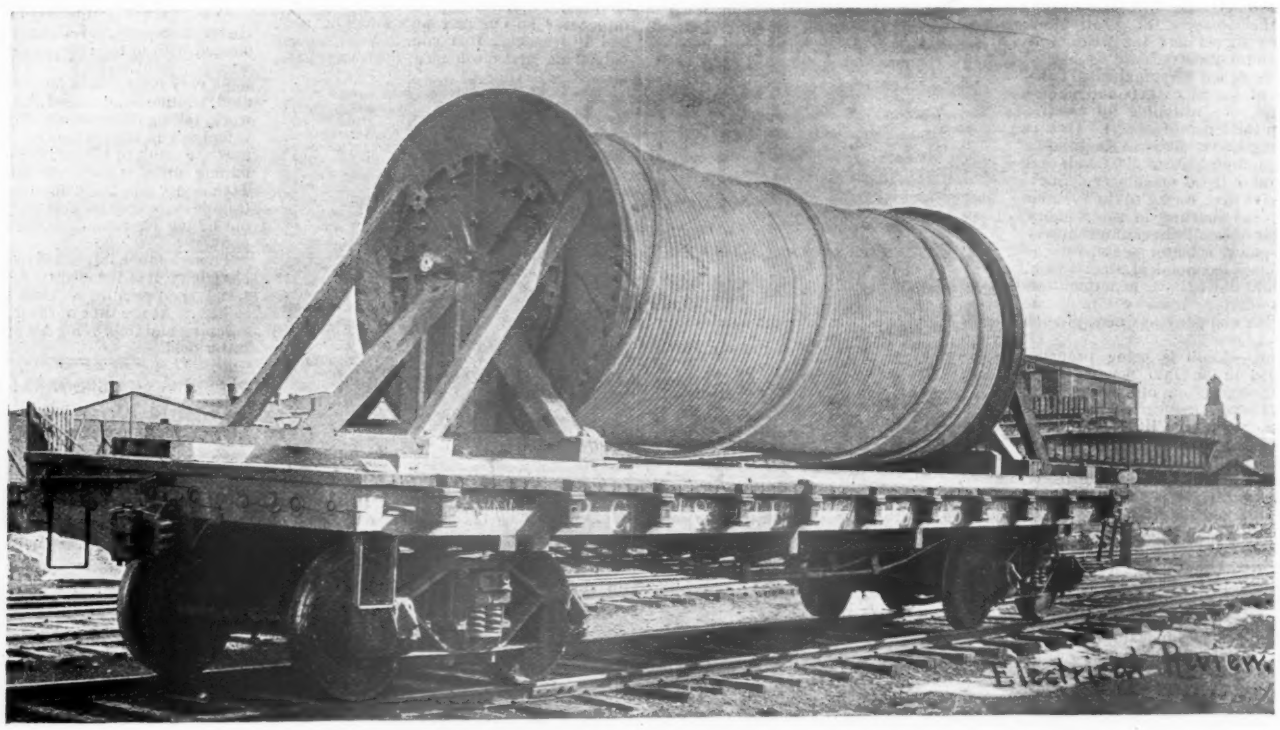
The illustration below represents the method adopted in the shipment of heavy submarine cables by one of our large manufacturers of insulated wires.

Through the courtesy of their superintendent we have been able to obtain a photograph of the same, together with the following particulars:

The photograph is of one of two cars which were recently shipped from the factory of the Okonite Company, at Passaic, N. J., to go South. The cut above represents a two mile submarine cable in one length, composed of 20 conductors, and its total weight is upwards of 70,000 pounds.

This has been accomplished through the agency of new machines which have recently been put in operation in this factory, and tends to show the progress made by the company in not being satisfied with remaining quiet, but always endeavoring to improve their machinery for the production of high class insulated wires and cables.

This company has just succeeded in closing a contract for laying underground in the city of Manchester, England, wires for the purpose of lighting the city. This wire will, in all probability, be made in their Manchester factory, which is now completed and in running order, thereby relieving the company of a tremendous strain on their facilities for turning out goods for export and interfering with their American trade.



View of Okonite Submarine Cable, Mounted on Car Ready for Shipment.

Insulation Resistances of Underground Cables.

BY C. GRAWINKEL.

The underground trunk lines in the German Empire have, ever since they were laid, been carefully tested for insulation every month. The insulation resistance (reduced to 15 degrees) in all those referred to has always been found to be higher in Summer, and this the author considers to be a fact, and not due to two sources of error to which he refers, viz., first, that the temperature corrections are made from English tables which were calculated for old fashioned gutta percha; secondly, that the temperature is determined by a copper resistance test which gives the mean temperature only of the line, *e. g.*, if half the line were at 10 degrees and the other half at 20 degrees, he shows that the insulation resistance will appear some 23 per cent. too high. With regard to the first, it may explain the fact that the resistance curve of the older cables is more approximately a straight line than those of more recent ones. Owing to the temperature difficulty, the author does not feel able to state definitely either that the cables have or have not altered slightly in insulation resistance.

Aging Spirits, Wines and Beer by Electricity.

(*Written for* Electrical Review, *by C. C. Stauffer.*)

Spirits obtained by the distillation of fermented liquors always contain, besides ethyl alcohol and water, organic acids, other alcohols, such as propyl, butyl, amyl, caproyl and oenanthyl, ethers formed by the reaction of the acids upon the alcohols, and fatty matters of a nature analogous to essential oils and camphors.

Raw spirits, before they become potable, or rather before they become acceptable to the palate of the connoisseur, must undergo a process technically called "aging." This, as its name implies, was formerly effected by suffering the liquid to rest for a long time, the longer the better. The hold of a sailing vessel was considered a particularly choice place on account of the motion of the vessel, and in books of a former generation are found frequent references to whiskey, which had once or more "doubled the Horn." It was well known that this aging could not be effected unless access of air to the spirits were permitted, and it was also known that gentle motion contributed to the success of the process. The air contained oxygen and the motion served to bring fresh portions of the liquid into contact with the air at the surface. This process is largely followed to this day and whiskey is kept under bond for one or more years until it acquires the requisite flavor and aroma. Many expedients for reducing the time required for aging have been tried and this article is intended to be a partial discussion of one of these means.

Aging is essentially an oxidation. Spirits in general consist mainly of water and ethyl alcohol ($C_2H_5.OH$). In addition to these there are found certain so-called essential oils, which are, in fact, some of the higher alcohols, their aldehydes, oxides or acids. The higher alcohols found in whiskey, for instance, are mainly propyl, butyl and amyl or pentyl alcohols, ($C_3H_7.OH$), ($C_4H_9.OH$) and ($C_5H_{11}.OH$), respectively, principally the latter. Theoretically, eight isomerides of amyl alcohol are possible, but of these only two or three are found in spirits, viz., isobutyl carbinol or inactive amyl alcohol, and active amyl alcohol or methyl ethyl carbinol. Probably normal amyl alcohol is also present in small quantities. The fusel oil of brandy contains hexyl or caproyl alcohol ($C_6H_{13}.OH$) and heptyl or oenanthyl alcohol ($C_7H_{15}.OH$), in addition to amyl and possibly propyl and butyl alcohols.

These higher alcohols which, with ethyl alcohol, are direct products of fermentation, all have a disagreeable and pungent smell and odor, and must be eliminated from the spirit by removal, or changed by oxidation into some pleasant smelling and tasting substance, before the product is ready for market. Their partial removal is effected by rectification and their further oxidation by aging. In addition to their offensiveness, these alcohols have a directly injurious effect upon the health, producing nausea and vomiting and at times a species of frenzied madness quite different from the satisfactory exhilaration produced by the imbibition of good spirit. In fact, according to some authorities, the toxic effect of such alcohols is in proportion to their respective places in the alcoholic series. The habit, which maintains in the moonshine districts of the South, of drinking new corn whiskey "warm from the still," has been held to be the cause of much of the crime, feuds and retarded development of certain sections of North Carolina and Tennessee.

Oxidation of the alcohols transforms them into ethers or oxides—not necessarily corresponding ethers, but sometimes ethers of other alcohols as well. Thus, amyl oxide, ethyl-amyl oxide, ethyl-propyl oxide and many others, may be formed. Oxidation may be effected also by the presence of oxygenating substances, like per-oxide of hydrogen, in the liquid, but for the purposes of this article our attention must be confined to that oxidation which results from the presence of electrically generated nascent oxygen. This oxygen must be formed by the decomposition of the water which forms so large a portion of the liquid. The small quantity of free acid present also serves very materially to reduce the resistance of the liquid. The freed oxygen immediately attacks the oxidizable substances present and it is possible that some of the liberated hydrogen acts in a similar manner. The subject is not entirely understood, but the foregoing is the generally accepted explanation of what takes place.

The current may be either direct or alternating. The direct current was, of course, the first to be employed, the earliest known application of electricity to this purpose being found described in an old British patent, No. 9,917, of 1884. Hull, the inventor, proposed to use a glass vessel containing about 10 gallons of wine and a Smee battery of six medium sized cells. The poles were of platinum and were placed about six inches apart in the liquid. The action when spirituous liquors were being treated was continued for several weeks. For the treatment of malt and vinous liquors a shorter time sufficed. The most acid condition of the liquor was at the positive pole, from which a quantity of liquor could be, from time to time, withdrawn if the acidity were too great.

In general, the process employed by Hull and outlined above, constitutes substantially the one still employed, though, of course, with modifications. These modifications, in general, consist in the use of other agents

in connection with the electricity. Thus Mont-Storm, in his patent, the first United States patent in this art, No. 57,009, Aug. 7, 1866, violently agitates the liquor for a long time so as to bring the freshly formed oxygen into contact with the unoxydized substances in the liquid. The passage of the galvanic current may be simultaneous or alternate with the mechanical agitation, but the former is preferred. The current, if sufficiently intense, by decomposing a modicum of the water in the liquid during its passage, tends to strengthen the liquor on the whole, while, at the same time, supplying a

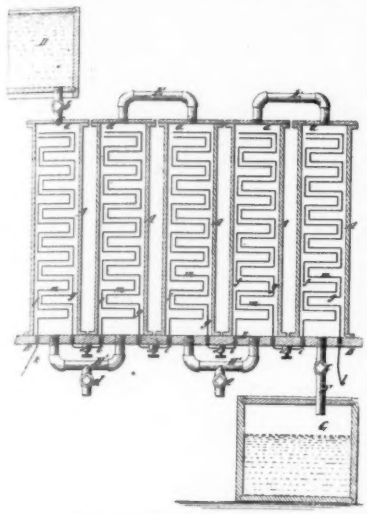


FIG. 1.—AGING LIQUORS.

portion of nascent oxygen and hydrogen for assimilation with it, but it is not assumed that the latter enters into combination.

The figure above shows a device employed by J. C. Vetter, and described in his patent No. 223,558, January 13, 1880.

In this the liquor is made to pass from the tank D through the vessels A in succession by means of the pipes E^1 and E, and is received finally in vat G. In its passage through the chambers A the liquor closes the circuit between the wires *f* and *g*, connected to a generator, which are extended in zigzag lines *m* across the vessels or chambers transversely to the direction of the liquor circulating through such vessels, as by this means the liquor is made to strike directly upon the electrodes. The liquid may be drawn off at the cocks *d* or *e*, if the treatment is to be comparatively slight.

J. L. Martin, in his patent No. 229,542, July 6, 1880, discloses the employment of porous cells made of baked clay or similar materials. Into these cells are placed carbon diaphragms or plates covered with platinum black. These cells are placed in a porcelain lined or glass tank.

A. C. Tichenor, in his patent No. 280,882, July 10, 1883, shows and claims a cloth covering for the negative plate. Unless covered, this plate is apt to become, in a short time, thickly coated or covered with a slimy or viscid substance that must be removed from time to time. By the employment of the cloth covering this substance, which is mainly fusel oil, together with any other impurities which may have been caught in the cloth, can be removed, with the cloth, from the liquid, and the latter can be cleansed and restored or replaced by a new one, as desired or found necessary.

T. E. Atkinson, in patent No. 312,948, February 24, 1885, describes an electrode of hard wood, charred all over and provided with a number of holes, extending transversely through the wood, and also charred. He uses two of these electrodes, and upon the passage of the current the liquid becomes impregnated with the flavor of the oak or hickory or other wood of which the electrodes are made. He also uses a covering for one electrode similar to that employed by Tichenor and described above.

A recent patent (Broyer & Pettit, No. 468,326, February 9, 1892) discloses an application of electricity to the production of ozone, an agent much employed for effecting the rapid maturing of spirits, on account of the energy with which it enters into combination with the fusel oil. A series of glass tubes are each provided with a spiral of aluminum wire within the tube and a similar one external thereto. The tube is about one centimeter in diameter and 45 centimeters long. The whole is inclosed in a second tube, also of glass, having its ends cemented to those of the one first named. Small openings are placed in the first tube near the cemented joints, establishing communication between the two tubes. The ends of the spiral are connected to the secondary circuit of an induction coil. If, now, a current of oxygen be sent through the tube while the primary coil is in connection with the poles of a battery, ozone will be formed. There are other patents for a similar purpose.

Most, if not all, of the processes above described are applicable to fermented, as well as to spirituous liquors. However, in the application of electricity to the aging of fermented liquors, a different, perhaps a merely additional, result is reached. In order that this may be clearly understood, a brief reference to the constitution of a fermented liquor, beer, for example, is in place. This beverage, as is well known, is made from an infusion of malt. Malt is grain in which the starchy matter has been converted into the sugar called maltose, by the action of diastase, during the sprouting of the grain. The malt is dried, ground, mixed with hot water and boiled, hops are added and the liquor made to ferment by the addition of yeast. During fermentation the sugar is converted by the action of the yeast plant, *saccharomyces cerevisiæ*, in part or wholly into ethyl alcohol. Other alcohols are also produced. Upon the purity and vitality of the yeast sown, the excellence of the product largely and, in fact, mainly, depends. The saccharomyces are numerous, and, besides the one desired, others are liable to appear, and other ferments of a different nature are sometimes present or are liable to come from the atmosphere or surrounding objects, and thus change or destroy the product after the main fermentation is complete. Besides the water, alcohols, lupuline and other flavoring matters present in beer, mineral substances, a little lactic acid and certain albuminoids in considerable quantities are present. These albuminoids constitute most of the vaunted nourishment found in beer. They are, however, liable to alteration and decomposition after the beer is ready for the market, owing to the agency of putrefying ferments, and it is due to this fact that the beverage cannot be kept under ordinary circumstances for any great length of time after it is once ready for the consumer. Various means have been employed to overcome this difficulty. Beer has been frozen and shipped in that condition, and frozen beer is even now a recognized luxury in some portions of the East. Salycilic acid and other antiseptics and poisons are sometimes employed, all of which are, of course, detrimental to the health of the consumer as well as to the flavor and character of the beverage. Another method, called after the name of its inventor, "Pasteurising," is frequently employed. In this method the liquid is heated in vessels closed from the air to a temperature of about 170 degrees Fahr., in order to kill all the microscopic life therein. Unfortunately, however, this temperature is high enough to coagulate the albuminoids present, and thereby render the beer turbid. If this cougulum be filtered out the beer will be found to have lost much of its characteristic flavor and nearly all of its nutritious matter. Other changes are also effected by the heating. The carbonic acid gas is almost all driven off and has to be forced by great pressure into the beer afterwards. This treatment, however, fails to effect a solution of the gas in the beer as complete and intimate as the original one naturally produced in the fermentation of the beverage.

The difficulties pointed out above are overcome, in part, if not entirely, by passing a current of electricity of sufficient power to kill the germs in the liquid through it. Any of the devices described in the foregoing paragraphs may be used for this purpose.

Electricity has also been used in a process called the induction process for the accomplishment of the same result. A form of apparatus for this p rpose is shown in the accompanying figure, which illustrates a device employed by E. J. Fraser and shown and described in his patent No. 339,540, April 6, 1886.

The body of the liquid is surrounded by a helix of insulated wire, placed either inside or outside the vessel, and a current is passed through the helix. He states that good results have followed from the use of a helix eight inches in diameter by 48 inches long, formed of insulated wire about No. 17 standard gauge, with a vessel of 10 gallons capacity and a suitable depth to enclose the helix. A "gravity" battery of one cell, six by eight inches, would be sufficiently powerful for the quantity of liquor mentioned. This apparatus is also intended to be used for liquors, although the probable effect in the treatment of them is not very clearly stated.

The patent to S. G. Cabell, No. 404,682, June 4, 1889, shows a structure of a form analogous to that of Fraser, with the exception that a current of the fluid, of which many kinds are mentioned, is made to flow through the helix, which consists of several layers of wire insulated and compactly wound. Several such helixes may be used, and the fluid may be passed through one or more at pleasure. This inventor has also patented other devices in which the so-called induction method is used.

A German patent to Fraser, No. 58,639, May 20, 1890, deserves mention in this connection, for the reason that the fluid is made to flow through a pipe which also contains an insulated wire, concentric therewith, so that the liquid, throughout its passage, is exposed to the inductive influence. A modification of this arrangement, in which the electric current passes through the pipe as a conductor, is also shown in this patent.

The process of making wire is essentially the same as that employed in the manufacture of beer, different materials being, of course, employed, with very different but not essentially different results, and the treatment of the one liquid is applicable, in general, to the other.

It is proper, before closing this article, to refer to three British patents to de Meritens, No. 13,293, of 1888, and Nos. 14,162 and 16,941, of 1889. The first of these patents rests its novelty upon the use of an alternating current. The water is decomposed and the nascent oxygen, instead of recombining with the hydrogen thus produced, burns or consumes the hydrogenized bodies in the liquid and combines with them to form water. The hydrogen also, it is stated, enters into combination with the oxygenized bodies foreign to pure alcohol. In his other patents, this inventor uses an alternating current in connection with sodium bi-sulphite or ammonia aniline, the phenyl diamines and their salts. From the sodium bi-sulphite sulphurous acid is liberated by the free acid in the beer, which acid reduces the aldehydes upon the passage of the current. The other substances used combine immediately with the aldehydes upon the passage of the current to form stable compounds, presumably ethers.

In all these cases the high resistance of the alcohol, as well as the water, is neutralized in part by the free acid and other substances present in the solution, and it is possible that in some cases harmless salts could be added to reduce the resistance of the liquid.

The practical development of this branch of industry is yet largely in its infancy. Doubtless, many schemes will be devised and tried before one which will satisfy all the requirements of brewers, distillers and wine growers, shall be discovered. The right and best method will, however, be eagerly welcomed in all these industries.

To the patents mentioned above, some of which have been patented in more than one

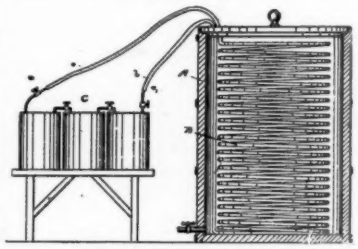


FIG. 2.—AGING LIQUORS.

country, the following may be added to complete the list in this art, viz.: United States patents to Martin, 64,990, May 21, 1867; Bradley, 108,558, Oct. 27, 1870; Martin, 222,293, Dec. 2, 1879; Thierman, 221,337, Aug. 17, 1880; Bendix, 287,089, Oct. 23, 1883; Cabell, 341,727, May 11, 1886; Cabell, 354,853, Dec. 21, 1886. British patents to Piggott & Beardmore, No. 2,007, of 1858; Wilson, No. 1,832, of 1877; Barlow, No. 4,541, of 1880; Jedge, No. 3,877, of 1883. German patents to Spilker *et al.*, No. 58,157, Dec. 12, 1889. French patent to D'Auxerre, No. 76,984, July 3, 1867.

A Note from Mr. Maynard in Reply to Mr. Vail.

TO THE EDITOR OF ELECTRICAL REVIEW:

I have read Mr. Stephen Vail's screed in the last number of the REVIEW, in which he takes upon himself the somewhat unusual task of attacking a newspaper correspondent, not for what he writes, but for what he does *not* write. He assumes that a correspondent of your paper cannot write a brief sketch relating to the telegraph without giving "facts, not only those of importance, *but all having any bearing on the subject.*" As the editor confined my article to one page of the paper, the responsibility for my not putting down "all the facts bearing on the subject" of telegraphy rests on him, and I leave him to settle the matter with Mr. Vail.

In regard to Mr. Vail's assault upon the reputation and character of Professor Morse, and his assumption that, because he painted portraits of his grandfather's family, and because he was pitifully poor, he could not have been an inventor, I have nothing now to say. I know something of the very important part Alfred Vail took in making the telegraph a practical success, and have gathered a good deal of information relating to the work of the leading persons who were associated in the undertaking, which I hope to embody in an article for the REVIEW at some future time. In the preparation of that article I should be glad to have any useful facts which Mr. Vail can furnish.

Faithfully yours,
GEO. C. MAYNARD.

Washington, D. C., March 15, 1892.

TELEGRAPHIC

.... The American District Telegraph Company will operate a messenger service in Great Falls, Mont.

.... At the recent annual meeting of the Union Switch and Signal Company, the following board of directors was elected: Geo. Westinghouse, Jr., A.W. Byers, Thos. Rodd, E. H. Goodman, W. Scott, Fitz-James, H. Willcock and Wm. McConway.

.... New York Board of Electrical Control reports to the Mayor for February show that during the month 549 telegraph poles and 483.4 miles of wire were removed, of which the Department of Public Works removed 152 poles and 134.2 miles of wire, and the electric light companies the remainder.

Telegraphic Service.

On the elevated road yesterday I met Mr. W. B. Somerville, superintendent of the press service of the Western Union Telegraph Company. Speaking of the recent change of a leading New York paper from the Associated Press to the United Press service, Mr. Somerville said: "I cannot discover any difference in its news by reason of its change, except that it is written in a little more sprightly manner than when the service was by the Associated Press. The real fact is that newspapers can get along without press association service at all if they are obliged to do so, because of the great reduction in the telegraphic rates for specials. As an instance of that reduction, eight or ten years ago the cost of Chicago specials to New York was four cents a word. Now they are delivered for one half a cent a word. In those days San Francisco specials were charged up at 10 cents a word. Now they are one and three-fourths cents a word. Washington at that time was charged at two cents a word. Now the rate is one-fourth of a cent a word. These are only leading examples of the reduction in rates of specials. They have made the production of a newspaper possible without any press association service whatever.

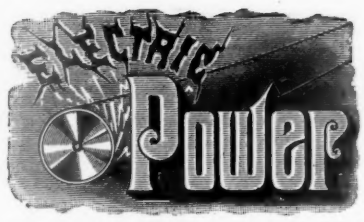
"You can get some idea of the growth of the newspaper service by telegraph," continued Mr. Somerville, "when I tell you that 10 years ago there were only about 50 papers that had special correspondents and received special dispatches in the United States. The total number of words of service for a year at that time was about 28,000,000. For the last year of record special dispatches were sent to over 500 papers in the United States and the aggregate number of words so delivered was 260,000,000. There is no knowing where this service will stop growing."—"*Ben Abou,*" *in N. Y. Press.*

True Words from Omaha.

"WHAT ELECTRICITY HAS ACCOMPLISHED —AS FASCINATING A NARRATIVE AS A FAIRY TALE."

[*From the Omaha Bee.*]

The publishers of the ELECTRICAL REVIEW issued a Decennial edition on February 20, which surpasses in literary excellence and typographical beauty any previous numbers of this weekly publication. The ELECTRICAL REVIEW is the first paper published in this country devoted exclusively to the science of electricity in all its varied branches, and it is evident that the proprietors have spared no trouble or expense to fittingly celebrate the tenth anniversary of the birth of this ably conducted periodical. In this number appears an interesting sketch of the history of the REVIEW and the progress made in the application of electricity within the past decade. The story of what the science of electricity has accomplished in the comparatively short space of 10 years makes almost as fascinating a narrative as a fairy tale. There are numerous finely executed handsome illustrations interspersed throughout this number, and, taken as a whole, it reflects great credit on the enterprising publishers.



* * The Huntington, W. Va., Belt Line people expect to put in an electric power plant for their line this Summer.

* * There are 3,800 men employed at the works of the Thomson-Houston Company. Their railway work is booming.

* * A bill has passed the Massachusetts Legistature permitting the use of electricity for motive power on the steam railroads of the State.

* * It is stated that one-half of the $500,000 required to build the electric railway from Downington to Coatesville, Pa., has been subscribed.

* * Seattle, Wash., has entered into negotiations by which all its street cars are to be run by electricity, by power taken from a waterfall 42 miles distant.

* * There are rumors of the formation of a syndicate to establish an electric railroad from Concord, N. H., to Boston, taking advantage of the local railway plants in Concord, Manchester, Nashua and Lowell.

The Trolley in Chicago.

On Monday last the Chicago city council passed the ordinances granting permission to the Chicago City Railway Company to use the overhead trolley wire on several lines. The ordinances were amended so as to provide that the overhead wires are to be strung only when and where permitted by the mayor and commissioner of public works. There was a stipulation, also, that the feeder wires from the power houses should be carried in underground conduits, in accordance with a provision of the ordinance in relation to this matter adopted last week in the West Division omnibus ordinance.

The amended section of the ordinance provided that if the company shall propel and operate its cars by electric power on Thirty fifth street, the overhead wires shall be suspended from poles set within the curb line limit of the street. The wires shall be suspended not less than 18½ feet above the rails, and the poles and supports shall be placed on an average of not less than 115 feet apart, except at the intersection of streets and avenues, when this distance would place the poles or supports on intersecting streets and avenues. Many South Side residents, especially those who reside in streets likely to be marked by the overhead electric railway system, place themselves unhesitatingly on record as opposed to it. Residents of Thirty-fifth, Forty-seventh and Fifty-seventh streets are smiling loudly because an amendment barred the overhead system on those crosstown lines.

The overhead system, if the terms of the ordinance passed Monday night are complied with, will be used on South Halsted street, from Archer avenue to the southern terminus of the tracks of the Chicago City Railway Company, and on Archer avenue, from State street to the intersection of Thirty-eighth street, as well as on the following thoroughfares:

From State street east on Sixty-first street to the terminus of the tracks on that street, and on Cottage Grove avenue from Sixty-first street to Sixty-third street, and on Sixty-third street from Cottage Grove avenue east to Stony Island avenue, and on Sixty-fourth street from Stony Island avenue to Madison avenue, and on Madison avenue from Sixty-third street to Sixty-fourth street, and on Grace avenue from Sixty-third street to Sixty-fourth street; Indiana avenue from Thirty-ninth street to Fifty-first street, and on Fifty-first street from State street to west line of Grand boulevard. M. J. B.

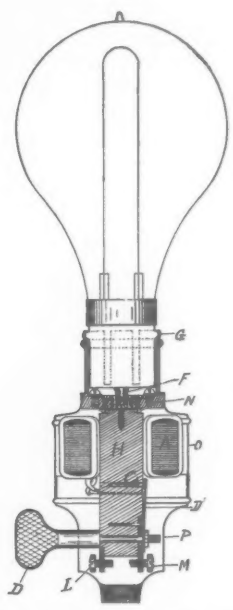
Chicago, March 17, 1891.

The Ries Regulating Socket for Incandescent Lamps.

We have already had occasion to refer to the regulating sockets for alternating current incandescent lamps invented by Mr. Elias E. Ries, and recently placed upon the market by the Ries Electric Specialty Company, of Baltimore, Md., by means of which the amount of light given by the lamp may be readily controlled in a manner similar to that of gas. The recent issue of a patent to this company, 470,402, of March 8, covering some of the later features of their new regulating socket, enables us to place before our readers a detailed description of the same.

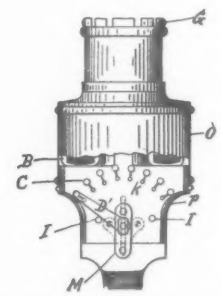
The accompanying illustrations explain the construction of the socket. Fig. 1 is a sectional elevation, Fig. 2 a side elevation with part of enclosing shell broken away, and Fig. 3 a diagram view showing the cell and circuit connections.

Fig. 1



As will be seen, the socket comprises a finely laminated iron ring, A, wrapped at one operation with a cable, B, composed of a number of well insulated copper wires, the ends of which are brought to a row of contact pins, C, arranged in the path of an arm, D^1, connecting to the operating key in such a manner that all of the wires of the cable are, by means of these pins, connected in series with each other and with the lamp. The coil thus formed is mounted upon an insulating-block, H, contained within the enclos-

Fig. 2.

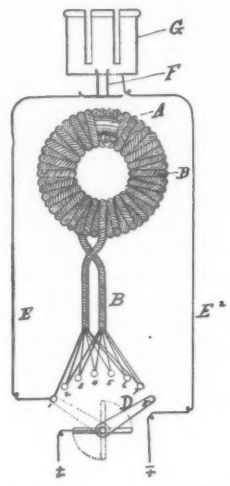


ing shell, O, to which block are likewise secured the lamp holding contacts, the operating key and the terminal or binding screws, L, M, to which the leading-in wires are attached.

When an alternating current flows, the core, A, acts to choke off the current more or less, according to the amount of coil cut in by the key. The magnetic lines of force produced by any wave react upon the winding, B, in such a manner as to generate a counter electromotive force or secondary current in the same, which flows in a direction opposite to that of the inducing current and tends to oppose or neutralize it, thus either entirely preventing or materially reducing the flow of current to the lamp by the simple reaction of the current upon itself and without the interposition of any resistance.

In this, when current rests on contact No. 7, only a small portion of the applied electromotive force sufficient to just render the lamp filament visible in the dark is permitted to pass to the lamp. As the arm, D^1, is moved toward the left over the series of con-

Fig. 3



tact pins, C, it cuts out successive sections of the winding, B, thereby correspondingly increasing the amount of light given by the lamp, until, when the arm finally rests upon contact No. 1, practically all of the coil sections are cut out and the lamp burns at its greatest brilliancy.

This socket contains nothing to get out of order or give trouble, is easily and rapidly wired, and has but one moving part, the arm D^1, which is made of aluminum bronze. The construction of the socket is such that it will take lamps of any voltage up to the normal voltage of the supply circuit, or of any candle-power up to its rated capacity, and at the same time regulate the brilliancy of the lamp from a fraction of a single candle-power up to the full capacity of the lamp, the current not used in the production of light being returned to the circuit, instead of being wasted in the development of heat, as occurs when resistances, such as German silver, iron, carbon, graphite, etc., are used for controlling the flow of current to the lamp or other translating device.

Anti-Sulphuric Enamel.

Acid spray from a battery of accumulators is said to be a great deteriorating agent where metal fittings and brass or copper conductors are about. A London firm set to work and invented an anti-sulphuric acid enamel, which is now largely used in many electrical works. For coating woodwork, iron and copper in the neighborhood of batteries it seems to have proved itself thoroughly successful, and the long list of names of electrical firms using this enamel shows its popularity and usefulness. Even with strong sulphuric acid it will resist for weeks. It is also a perfect protection against acid spray. It is applied exactly like varnish, in black or other colors.

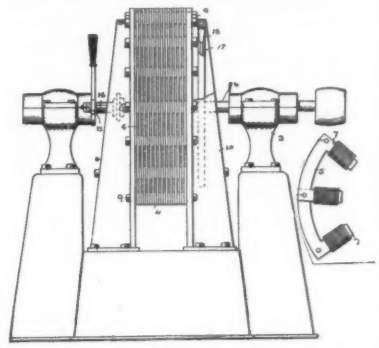
Electrical Works in Elmira Bought Up.

A syndicate composed of the Mayor of Elmira, N. Y., and a number of the leading bankers and other prominent capitalists of that city, have obtained control of the Elmira water works, the Elmira gas works, the Elmira electric light works, the Electric street railway system of 23 miles, and the Inter-State Fair Association, which will be put under one management, as the Elmira Municipal Improvement Company. The price paid for the five plants is $2,600,000. Henry Clews & Company, of this city, have been appointed the bankers to place the securities. D. C. Robinson, Mayor of Elmira; General Woodward, president of the Third National Bank, New York; Jackson Richardson, president Elmira National Bank; Hon. Smith M. Weed, of Plattsburgh, N. Y., and D. Graham, president of the Montreal and Chicago Shipping Company, it is stated, are in the syndicate.

PROGRESSIVE ELECTRICAL PATENTS.

ALTERNATING CURRENT GENERATOR.

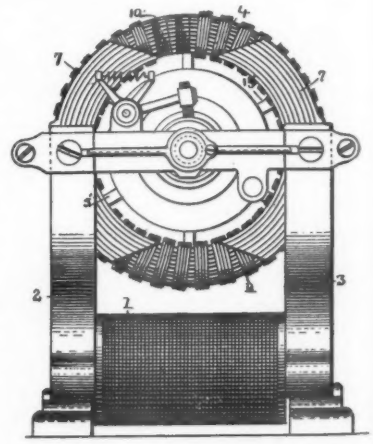
In a patent recently issued to Thomas A. Edison is described an alternating current generator, in which the field magnet is built up of sectional plates, a series of plates being used in each layer to form a ring, with air spaces between the several plates, through which air is forced during the operation of the machine by a fan mounted on a shaft. This structure will be understood from the accompanying engraving, showing a side elevation of the machine and, in detached view, several of the sections. A peculiar feature of the machine is that the field magnet poles are bridged by a thin strip of sheet iron, this strip forming a closed ring bearing against the poles of the field magnet, by



which it is held in tight contact magnetically. It is said that this sheet iron ring adds materially to the efficiency of the generator and reduces the heating of the machine. The explanation offered is that the sheet iron ring spreads the fields on each side of the pole-pieces, so that the changes of polarity are more gradual than in machines where the several poles are disconnected. The fan is mounted on the armature shaft, and provided with a series of wings, which force air through the spaces between the laminæ of the field magnet.

PREVENTING HUMMING IN DYNAMOS.

According to Mr. Edison, in a patent recently issued to him, the humming noise in a dynamo electric machine may be prevented by laminating the pole-piece and shaping it as indicated in the accompanying engraving,

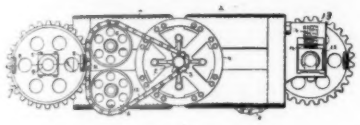


so that the edges of the pole-piece slant at an angle to the armature coils. In the structure shown, the field magnet is composed of four laminated segments, two on each side of the armature, the edges of each segment being cut so as to slope at an angle to a radius drawn from the center of the armature.

CAR MOTOR.

A novel system of gearing for a car motor, invented by Mr. Edison, is illustrated in the accompanying engraving. A sprocket chain is used, but is so supported that the driven gear engages with the sprocket chain to the extent of but a few of its cogs. The motor is supported between the car axles, and a gear wheel, 2, on its shaft gives motion to the sprocket chain, 12. This passes over two idlers, 6, and engages with a few of the teeth of the gear wheel, 7, which operates

upon the car axle. By this construction the chain can be made much shorter than in arrangements of this kind heretofore used, wherein the chain passes around the driven sprocket wheel. As the motor pulls on the chain it tends to straighten it between the bearing surface of the two idle pulleys, thereby holding it firmly against the driven



wheel. The friction of the chain on the sprocket is largely reduced, because it engages only a few teeth. The motor acts upon both car axles, a system of gearing precisely like that just described being mounted upon the other side of the motor and driving gear wheel, 18, mounted upon the other axle of the car.

LIGHTNING ARRESTERS.

Alexander Wurts, Pittsburgh, who read an interesting paper upon the subject of lightning arresters before the American Institute of Electrical Engineers on the 15th inst., has patented several interesting types of lightning arresters which are worthy of notice. One of these is shown in the accompanying engraving, Fig. 1, comprising a series of brass cylinders, B^1, B^2, B^3, B^4, etc., mounted upon thermostatic posts which, under the influence of heat, will bend the cylinders out of contact. The cylinders

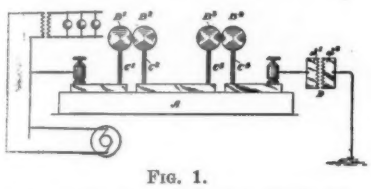


FIG. 1.

should be normally in contact or within very close relation to each other. The device is placed in a branch from the circuit to be protected to the earth, and preferably an ordinary saw-tooth lightning arrester is placed in series with it, as indicated in the engraving. The difficulty with the ordinary saw-tooth lightning arrester, when used in connection with dynamo electric circuits of considerable voltage, is when the line is struck by lightning, the lightning, in leaping from one arrester plate to the other, forms an arc which starts a leak for the dynamo current, and such current preserves its own arc, resulting not only in the destruction of the lightning arrester, but in possibility of fire and injury to the dynamo circuit. Mr. Wurts has discovered an interesting property of certain metals, such as zinc, antimony, bismuth, and their compounds, by which an arc, especially an arc formed by an

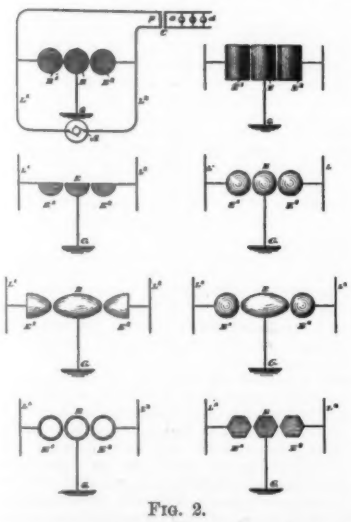


FIG. 2.

alternating current, will not be maintained between two surfaces of such a metal. For example, the cylinders, B^1, B^2, B^3, B^4, being made of brass, which contains a certain proportion of zinc, if an arc should start at the lightning arrester, D, the current passing through the thermostatic arms C^1, C^3, C^5, etc., will heat them sufficiently to separate the electrodes B^1, B^2, by the unequal expansion of the thermostatic elements of the arms. If constructed of copper, an arc would be maintained between the electrodes, but when made of brass, the arc is instantly put out and, of course, the arc between the lightning arrester plates at D is also interrupted.

In Fig. 2 is shown a variety of forms which may be given the electrodes, and these may be used, as there shown, to protect

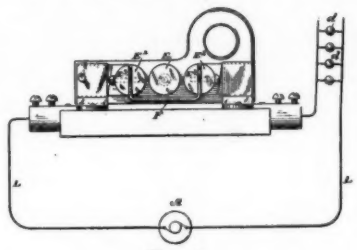


FIG. 3.

a circuit without the thermostat. The two upper diagrams indicate a cylindrical shape, the inner cylinder being connected with ground and the two outer cylinders to the line terminals, the next group indicating half cylinders and spheres as electrodes, the next group various combinations of ellipsoids, and the next group hollow cylinders and hexagonal prisms. The peculiar feature of this lightning arrester is the fact that it works efficiently only when the electrodes are placed in close relation. The distance between the electrodes should be from a sixteenth to a sixty-fourth of an inch; if made more than this, as, for instance, a half inch, the peculiar property the brass has of interrupting the arc is lost. Mercury and cadmium also have this property, in addition to the metals above mentioned.

In Fig. 3 the invention is shown as applied to a fuse, wherein the cylinders (E, E^1, E^2) are of brass and F is a lead or other fuse wire. When the fuse is blown, the arc, instead of following the fuse, springs across the electrodes (E, E^1, E^2) and is instantly interrupted by their peculiar property. The inventor thinks that the vapors of these metals are non-conducting and that this will account for the phenomenon. This does not, however, seem to explain the fact that the device is efficient only with an alternating current and not with a direct current. Another use contemplated for the invention is in switches, the two terminals of the switch being formed of brass cylinders and a non-conducting switch arm being used to separate them and open the circuit. When the switch arm is removed the two cylinders come together and close the circuit. When the circuit is opened by the introduction of the switch arm no destructive arc is formed, thus dispensing with the necessity of the snap switch action now in general use.

In Fig. 4 is illustrated another type of lightning arrester, designed by Mr. Wurts, to protect both alternating and direct current circuits. A^1, A^2 represent direct and A^3, A^4 alternating current generators discharging into work circuits. For the purpose of relieving these conductors from whatever static charge they may acquire, especially during a thunder-storm, means are provided for connecting them at rapidly recurring intervals with a discharge circuit H. This circuit has interposed in it lightning discharge points, consisting of plates h^1 h^2, having teeth projecting toward each other, as shown, or other suitable form of discharge points may be employed. They are separated from each other by a distance dependent upon the circumstances, being sufficiently near to permit the static charge to escape from any given line to the earth at the moment that line is connected with the discharge circuit. This may be accomplished by means of some suitable device, such as is illustrated in the figures, which may be driven by a generator shaft, which will serve to connect one line at a time with the discharge circuit and to interrupt its connection before the succeeding line is so connected.

Any excessive static charge upon a line will then be conducted to the plate h^1 and across the intervening air space to the plate h^2, and thus escape to the earth, and immediately the arm k will pass to the next succeeding plate and tend to equalize the charge of the line with that of the earth. This operation is repeated as rapidly as may be necessary to keep all the circuits in a comparatively neutral condition with reference to the earth, thereby relieving them all from any tendency to discharge through the armature of the machine or in any other manner

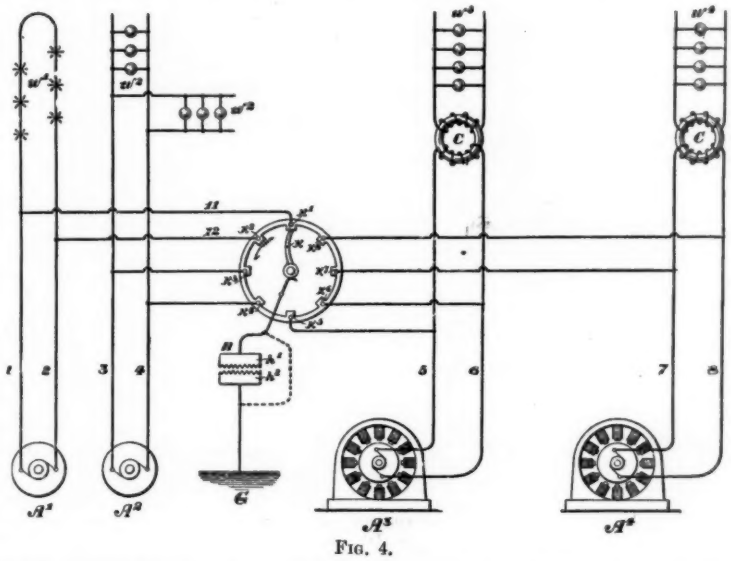
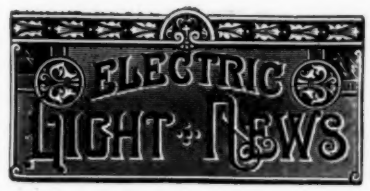


FIG. 4.

which would be injurious to the apparatus or to the system. It will be noticed that no machine can be short-circuited by this discharge apparatus, since only one terminal of any given machine is connected with the discharge circuit at the same time.



—— Homer, O., has voted in favor of electric lights.

—— Rumor has it that Westminster, Ind., is to have an electric light plant.

—— Westfield, Pa., has voted in favor of establishing an electric light plant.

—— J. H. Harrell, of the banking firm of Jasper Harrell & Son, is talking of erecting a lighting plant in Visalia, Cal.

—— Lewisburg, Penn., has closed a contract with the Washington Construction Company (Pardue & Messner) to furnish arc and incandescent lighting for a term of five years.

—— *The Boston News Bureau* states that 179,000 shares of the Thomson-Houston common and 110,000 shares of preferred stock have been deposited in accordance with consolidation agreement, and a considerable amount besides has assented to the plan.

The Austrian Method.

[*Brooklyn Standard-Union.*]

The Austrian method of execution seems to be but a slight improvement on electrocution. The Austrians swing a halter over the neck of a murderer and string him up, while the executioner-in-chief, wearing white kid gloves, calmly beholds the victim wriggle, and two ponderous assistants pull him down by the legs. This is almost as hideous as the Mugwump method of seating a condemned creature in a chair and giving him a thousand volts.

Arc Lighting Figures.

The investigation by Lebanon, Pa., recently, of the subject of arc lighting for its streets, brought forth some interesting figures as to prices charged. These figures are authentic, we understand, coming direct from the proper officials of the places named, and are given in a condensed form below.

Whilst the data are valuable for some purposes, they are insufficient in detail to permit exact comparisons as to the relative cost of lighting in places of similar size, etc.

To accomplish this end, the totals should be based upon the same items of expense and these items charged in each case:

COST OF ARC LIGHTING IN 38 AMERICAN CITIES.

Name of Place.	No. lights.	Cost per annum.	Hours lighted.	City plant or private Co.	Candle-power.	Cost of plant.	Cost of operation.
Allentown, Pa.	101	$100 00	All night exc. m'light.	Private Co.	2000		
York, Pa.	170	91 25	" " every night.	" "	2000		
Oil City, Pa.	100	80 00	" " " "	" "	2000		
Reading, Pa.	228	109 50	" " " "	" "	2000		
Columbia, Pa.	45	85 00	" " exc. m'light.	" "	2000		
Williamsport, Pa.	170	80 00	" " every night.	" "	2000		
Stroudsburg, Pa.	29	67 00	" " exc. m'light.	" "	2000		
Erie, Pa.	218	120 45	" " every night.	" "	2000		
Harrisburg, Pa.	285	90 00	" " " "	" "	2000		
Easton, Pa.	108	80 00	" " exc. m'light.	City plant.	2000	$36,000 00	$8,600 00
Wooster, Ohio.	69	70 00	Philadelphia schedule.	Private Co.	2000		
Painesville, Ohio.	69	43 00	Until 2 A. M.	City plant.	2000	12,000 00	2,967 00
Concord, N. H.	52	100 00	Midnight.	Private Co.	2000		
Union, City, Ind.	28	91 25	Philadelphia schedule.	" "	2000		
South Bend, Ind.	110	100 00	All night, every night.	" "	2000		
Madison, Ind.	86	58 00	Philadelphia schedule.	City plant.	2000	20,000 00	5,000 00
Aurora, Ill	118	67 99	" "	" "	2000	33,465 92	8,020 00
Paris, Ill.	60	41 67	" "	" "	2000	10,000 00	2,500 00
Decatur, Ill.	60	60 00	" "	" "	2000	25,000 00	3,600 00
Cortland, N. Y.	50	109 50	" "	Private Co.	2000		
Binghamton, N. Y.	280	133 23	All night, every night.	" "	2000		
Lockport, N. Y.	150	72 00	" "	" "	2000		
Albany, N. Y.	.....	144 18	" "	" "	2000		
Syracuse, N. Y.	541	109 50	" "	" "	2000		
Dunkirk, N. Y.	58	44 76	" "	City plant.	2000	10,000 00	2,596 00
Baltimore, Md.	962	127 75	" "	Private Co.	2000		
Trenton, N. J.	200	138 70	" "	" "	2000		
Hannibal, Mo.	55	50 00	Philadelphia schedule.	City plant.	2000	20,000 00	2,750 00
Charleston, S. C.	110	100 00	" "	Private Co.	1400		
Gloucester, Mass.	23	96 00	Midnight.	" "	2000		
Bath, Me.	40	150 00	All night exc. m'light.	" "	2000		
Lewiston, Me.	95	43 00	" " " "	City plant.	2000	15,000 00	4,000 00
Ypsilanti, Mich.	85	35 35	Philadelphia schedule.	" "	2000	27,000 00	3,000 00
Topeka, Kan.	184	90 50	All night, every night.	" "	2000	55,447 98	16,657 00
Troy, N. Y.	302	142 35	" "	Private Co.	2000		
Philadelphia.	1752	160 00	" "	" "	2000		
Chicago, Ill.	1000	100 00	" "	City plant.	2000	500,000 00	100,000 00
	196	175 00	" "	Private Co.	2000		
Lebanon, Pa., Edison Co's bid for 1892.	100	98 45	" "	" "	2000	.....	9,845 00
Lebanon, Pa., Schuyler Co's bid to e'ct plant for city, including ground.	100	68 20	" "	City plant.	2000	20,000 00	6,820 00

HIGH POTENTIAL TRANSMISSION.

BY PROF. ELIHU THOMSON.

The electrical engineer, when he has before him the problem of conveying electrical energy through comparatively great distances, without excessive loss and without excessive amounts of copper in the conductors, is compelled to consider the use of high potentials.

Of course, potentials are high or low relatively to others taken as standards, but by a sort of common consent it has come to be regarded that when the electromotive force is sufficient to cause the current to leap, or when there is a striking distance which is easily perceptible, the case may properly be called "high potential."

It implies the existence of thousands of volts potential difference. The strain on the dielectric or insulating material is such that a high insulation resistance is demanded to prevent large leakage. The current passes at a "high tension," or is a "high tension" current.

The time at the author's disposal will not permit more than a brief reference to different combinations of apparatus in which high potentials may be effectively employed.

Let it be desired to transmit several thousand horse-power from a water-power to a distance of, say, 20 miles or more, and deliver it at one point as power. What plant should we use? Direct current or alternating current?

Owing to the difficulty of constructing commutators which are suitable for such high potentials as 5,000 volts, especially where the current is large, it is evident that neither dynamos nor motors can be used in which the full potential is either generated or used. This assumes the use of a direct or continuous current as the means of transmission. In such case either the voltage must be kept down to, say, 1,500 to 2,000 volts, or the dynamos and motors must be run in series sets.

It is questionable whether commutators can be commercially successful on which the pressure exceeds 1,500 to 2,000 volts, with large currents flowing. They are very difficult to construct and to maintain. Besides, they require to have so many segments between the brushes that the armature winding and connecting is made more delicate and liable to injury. The cost of construction becomes excessive. When the voltage does not exceed 1,000 volts these difficulties do not present themselves. Hence, to use continuous currents in the case assumed, and to take advantage of a high line potential to secure immunity from line losses and allow a moderate outlay in copper to suffice for the transmission, it will be necessary to connect several dynamos in series in the generating station and several motors in series at the receiving station. These machines may be belted to a common shaft. With this arrangement it would be possible, by mounting the machines on insulating bases, to work with such high potentials as 20,000 volts by having 20 machines of 1,000 volts, each connected in series at each end of the line. This with each machine of 500,000 watts output would transfer energy at the rate of 16,000 horse-power.

The machines, both generators and motors, could be series wound and be practically self-regulating as to speed under varying loads, providing all the machines are mechanically driven together as one or deliver power together. The construction presents no great difficulties and the efficiency under all loads, except quite light loads, could be made high. But the condition of combined driving and delivery of power destroys much of the attractiveness of such a system. Considerable portions of the plant could not be thrown off without destroying the conditions.

There is no method of transformation for direct currents which would not involve the commutator difficulty. It is evident that we must look to alternating currents as a means of transmission at high potentials.

For large transmissions it is evident that the system adopted should permit the construction of dynamos of as large capacity as 1,000 horse-power, so as not to multiply machines to too great an extent. It is also requisite that the construction be such that parts are readily accessible and easy to repair in case of accident.

In the employment of alternating currents we have choice of various ways of working.

It is probably not easily practicable to construct alternating dynamos or motors to make use of currents at over 3,000 or 4,000 volts without transformation. It would appear then that if the distance is great enough to compel the use of currents at higher pressures than 3,000 or 4,000 volts, transformation will become necessary; in which case the voltage of the generating dynamos and of the receiving machines can be as low as desired.

But the interposition of a set of transformers for raising the potential at the generator and another set for lowering it at the receiving end is an added expense for plant which must be balanced against saving of cost of construction of the machines and line. The percentage of loss involved in the use of transformers, due to losses incurred in the transformation, is not necessarily so great as to be serious. It can probably be brought down to about five to six per cent. under full load for the double transformation.

In the transmission of power by such a method, the losses, then, are those of the line, the double transformation and the dynamos and motors. The total loss need not exceed 25 per cent. under full load condition.

If the transmission is for lighting, and the transformation down at the receiving end is made to give the voltage required for the lamps, the motor losses would be supplanted by losses on the local mains or local distribution. If motors be run from such lines the losses are, of course, increased by the drop in reaching them, depending on their distance from the transformers which feed current to them. It will sometimes be found practically impossible to transform down directly to lamp potential from the high potential of transmission. This is the case when it is not permissible to carry the high potential lines to transformers placed here and there in a city. In such cases an intermediate transformation may be resorted to, but it, of course, involves more cost of plant and another three per cent. loss or thereabouts. Dear fuel and very abundant water power may sometimes warrant such procedures.

In all such cases of cumulative drop, difficulties arise from the fall of potential under load, and adjusting devices at the transformers or on the lines may require to be employed.

Fortunately, variations in the voltage may, with alternating currents, be effected by the use of variable reactive coils instead of resistances, and regulation may be obtained with fair economy. As regards the single phase alternating currents, involving the use of but two lines, which is the system commonly used, nothing more is required for such work as lighting, and it is to be hoped that self-starting effective motors may be forthcoming for use on such systems. Progress has certainly been made towards securing such motors and a year or two hence we may find many in active service on existing lines.

For power transmission a reversed alternating dynamo, if of a good type, is also a good motor when brought to synchronism, and it has the advantage of maintaining a speed as regular and constant as the speed of the generators at the other end of the line, but it has also the serious disadvantage of requiring to be brought up to full speed before it will work at all. It is essentially non-starting. Too much complication is introduced into the plant by the introduction of elaborate devices for starting. It has been proposed to start such motors by connection with a small, not necessarily, very efficient motor of the self-starting variety, of which there are several quite suitable for the purpose, working by alternating currents of single phase.

Where the power is to be delivered *en masse* at a receiving station, it is possible that such methods of working may become important. Alternating dynamos are now constructed which, when even of moderate capacity, have a commercial efficiency of considerably over 90 per cent. and therefore approach, if not equal, the best types of continuous current apparatus. These machines, reversed and used as motors, may be expected to have an efficiency equal to their rendering as dynamos and are easily made self-exciting.

Great interest has recently been excited from the use of the three phase alternating current, or rotary current, in the Lauffen Frankfort transmission. This experiment, covering a distance of over 100 miles, was successful as far as the technical matters involved were concerned. It was not intended as an exemplification of a commercial transmission. It served its purpose in proving the possibility of working with alternating current of very high potentials, and also showed in a striking manner certain features of the multiphase system.

Let us assume that we have a station in which the dynamos are excited by a continuous current, and that the armatures are provided with a three branched conductor similar to a Thomson-Houston arc machine, but with three collector rings instead of the three commutator segments, three separate brushes bearing on the rings. Or, if the field of the dynamo revolves, the connections are made directly to the stationary armature coils. The three wires may, in other cases, be connected to points in a continuous or Paccinotti winding, such that they are virtually taken at 120 degrees apart in a bipolar machine, 60 degrees in a four pole, etc. In such cases we will have three lines leading from the generators, in which lines alternating currents may flow with the waves displaced relatively 120 degrees, or in which when any one current wave is at its maximum, the two others are nearly at their mean value, one rising and the other falling. This has been called a "rotary current" abroad, but it is no more rotary than any current is. In fact, it is no more rotary, as a current, than is steam which is fed by three steam pipes to three cylinders of an engine, in which the cranks are set 120 degrees apart around the shaft. It is true that such currents are capable of producing a rotary magnetic field, just as is a two-phase system, but a rotary field is also produced by the rotation of a set of brushes around a commutator attached to an armature of the ordinary continuous current type, such a current being passed in by the brushes.

By the use of transformers the three-phase alternating currents can be transformed up or down as with a single-phase current. Specially constructed transformers permit a combination of the magnetic circuits of such transformers in a manner to form, as it were, a triplicate transformer, having certain advantages which will not here be dealt with. It is evident, however, that the advantages of high potential transmission may be obtained in this system by transformation, while low or moderate potentials may exist at the dynamo and motors.

In the reconversion of energy of three-phase currents back into power we have choice of two types of motor: First, the reversed three-phase generator, which synchronizes in speed perfectly with the generator; second, the three-phase non-synchronous motor, which changes in speed or requires regulation for differences of load.

The former requires its field magnets to be excited with continuous currents, and will not necessarily start itself. It will, however, start along with the generator while the latter is starting if the fields of both be excited strongly and no great load be on the motor machine.

The machine is simply a three-phase dynamo reversed; current being delivered to the three connections of the three branched armature conductor and the field excited continuously, as in the dynamo.

The non-synchronous type of motor becomes, by proper proportioning, practically capable of maintaining a speed which does not vary over a few per cent. from light to full load; it requires no exciting current and starts under load. In construction it is simply a structure in which a rotating field, set up by three currents of a three branched or suitably arranged conductor in a laminated iron mass, called the field, drags around a movable armature carrying a system of closed conductors in which strong currents are set up by the moving lines from the field, which acts to close its magnetic circuit through the armature iron. Thus the rotating bundles of magnetic lines, in cutting the armature conductor, push such conductor along by virtue of the reaction of the opposing currents set up in the armature conductors or closed circuit. Such motors, not being reversed dynamos, cannot act to generate current if revolved by power. Their great advantage is that they may be placed anywhere where convenient to receive current from the mains direct or from transformers, they may be started or stopped at will and have no commutators. That they may be made quite efficient is quite evident; that is only a question of proper designing. Both forms of motors mentioned for three-phase currents will doubtless have their uses. While lights may be run from three-phase current systems by transformers, or directly from the mains if the potential be proper, such systems possess no peculiar advantages over the single-phase systems, except that in the generation of three-phase currents a smoother action of the dynamo is obtained, and probably, therefore, a slightly increased economy, or, perhaps, a little greater output.

There is another important way in which the three-phase currents may be utilized at the receiving end. They may readily be transformed into continuous currents of low potential or of any potential practicable for commutation. The means for transformation in this case is a motor generator of special construction. It possesses an armature winding and connections suitable for three-phase currents, a field magnet system excited by continuous currents from any suitable source and acting on the armature, a secondary winding on the armature, or the same winding as that connected to the three-phase mains, with the usual numerous connections to the segments of a continuous current commutator, upon which brushes suitably adjusted take off continuous currents. These may be used for lighting, for running continuous current motors, etc. Motor generators giving 500 volts continuous current, 220 volts and 110 volts are easily worked from the same system of three-phase mains. The excitation of these machines may be obtained from their own commuted currents; they are self-propeling after having been started along with the generating plant, or may easily be brought to speed before connecting with the three-phase supply by continuous current from another machine in work; they can be compounded for drop or potential in themselves and the lines leading to and from them.

The future supply of electricity in a large city, for all purposes, at any desired voltage of continuous or alternating current, would seem to involve a system about as follows:

ELECTRICAL SUPPLY IN A LARGE CITY.

A generating station conveniently located for obtaining water for condensing, cheap fuel delivery and ready disposal of ashes, containing huge triple compound condensing engines driving large dynamos, delivering, either directly or through transformation upward, high potential three-phase currents; a system of high potential mains for three phase currents, probably consisting of sets of three conductors with a heavy open braid or net-work covering, tightly woven on and drawn into an iron pipe filled with insulating oil, placed underground to avoid atmospheric disturbances; sub-stations containing compound three-phase motor generators feeding into the street mains at the desired potential for lights and continuous current motors; motor generators feeding currents of suitable potential for street car propulsion; alternating current transformers delivering currents of alternating character at desired voltage for lighting and for driving commutatorless three-phase motors.

There is no electrical service which could not receive its supply from such a system. The time is, perhaps, not quite ripe for such a comprehensive scheme, but its advantages are obvious to those familiar with the present conditions of supply in large cities.

Time has not permitted the extension of this paper to cover matters of detail, however interesting, and an attempt has simply been made to review, in a brief manner, the salient points of several systems involving high potential transmission.

The purpose of the paper has not been to present any of the history of the growth or development of these various systems touched upon, nor to enter into any of the refinements of theory or practice with such systems, a proper consideration of which question would be very lengthy and consume more time than is at our disposal.

The question may be asked: What are the highest potentials which can ever be made available in electric transmission? Any answer given will necessarily imply foretelling the future practice—a very hazardous thing to attempt. Such answer may, however, be taken to relate to either a single phase alternating system or a multiphase, the only difference being in the number of conductors employed. In fact, it is conceivable that the number of conductors in a single phase system be reduced to one central conductor surrounded by a tube or by several conductors, all enclosed and insulated from a surrounding pipe. Let the pipe be filled with oil and the conductors be separated by being wound with an absorbing net of dry cotton, and let the covering of oil extend over the conductors and be unbroken, practically, over the the whole of the high potential conductor, including the fine coils of the transformers at each end of the line, and we have a system in which the employment of very high potentials may become quite feasible. If we provide in the thickness of our oil insulation a sufficient margin of safety from puncture, and so calculate our line that its self-induction and capacity compensate for one another's effects, it would seem that there would be no difficulty from leakage, or from Ferranti effects, as they are called. The condenser effect of the Ferranti cables is large, while the self-inductive effects are small. Condenser action tends to accelerate the phase at the dynamo, and self-induction retards or lags the phase of the currents, and it would seem that by distributing the capacities and self-inductions properly the normal

phase, without either acceleration or lag, could be maintained.

A layer of good insulating oil, one inch thick, between rounded smooth metal surfaces, will equal in resistance to puncturing a potential which will cause a spark in air over 30 inches long. At least the author's tests on this subject point to an approximate relation of 1 to 35 or 40 in dielectric strength between air and good heavy paraffine oil. As nearly as can be estimated, a spark between rounded surfaces at 30 inches in air represents not less than 500,000 volts, and the author's experiments go to show that such potentials can be "kept down," so to speak, in a bath of oil. Whether the condenser effects of a long line would introduce serious difficulties it is impossible to say, but provided that the rate of alternation or periodicity be kept low and the insulation maintained by covering every inch of the high pressure conductors in, say, two inches thick of oil, it might even be possible to work with 500,000 volts. Allowing a loss of only 10 per cent., or 50,000 volts, with a double conductor conveying 200 amperes, each conductor having about one-twelfth of a square inch section, a distance of about 240 miles would be covered and the energy carried would be 100,000,000 watts, or over 139,000 horse-power. These are striking figures and are only given by way of illustration. They may never be needed to be used in practice, yet the difficulties of realization are less than at first appears; the condenser action of the line being the most serious matter to be dealt with. Such a line is even safer, so far as life risks are concerned, than an overhead line of much less pressure. In fact, it may be said to be practically safe. Any interference with the line is difficult on account of the pipe enclosing it, and on the first weakening of the insulation, or before a break in the pipe became complete, a short circuit of a moderate current would take place and the fuses be blown at the ends of the line. Pipe lines are laid for the conveyance of oil—why should they not be laid for the conveyance of electric energy where it can be done economically? Looked at from the standpoint of very high potentials, Niagara may be said to be gradually approaching the surrounding cities.

A Large Move in the Cold Rolled Steel Trade.

The Wilmot and Hobbs Manufacturing Company, of Bridgeport, Conn., have just purchased the property of the Bridgeport Rolling Mill Company. The original cost of these works was in the neighborhood of $100,000, and they have been in operation for a year past, under lease, by the Stanley Works, Alfred N. Stanton having the direct management. This plant is located on the harbor at Cedar Creek, and on a branch of the N. Y., N. H. and H. R. R., and within about one block from their already extensive cold rolled steel works, thus giving the best of water and rail transportation facilities.

They have for a long time been contemplating the erection of a hot rolling mill, for as all of the cold rolled sheet and strip steel which they produce has first to be hot rolled from their special billets into long strips before the cold rolling takes place, and in having the hot rolling mill also under their immediate control or supervision they get many advantages, and are now able to materially reduce the enormous stock of steel which they have heretofore been compelled to carry in the form of a multitude of widths and thicknesses of the hot rolled strips.

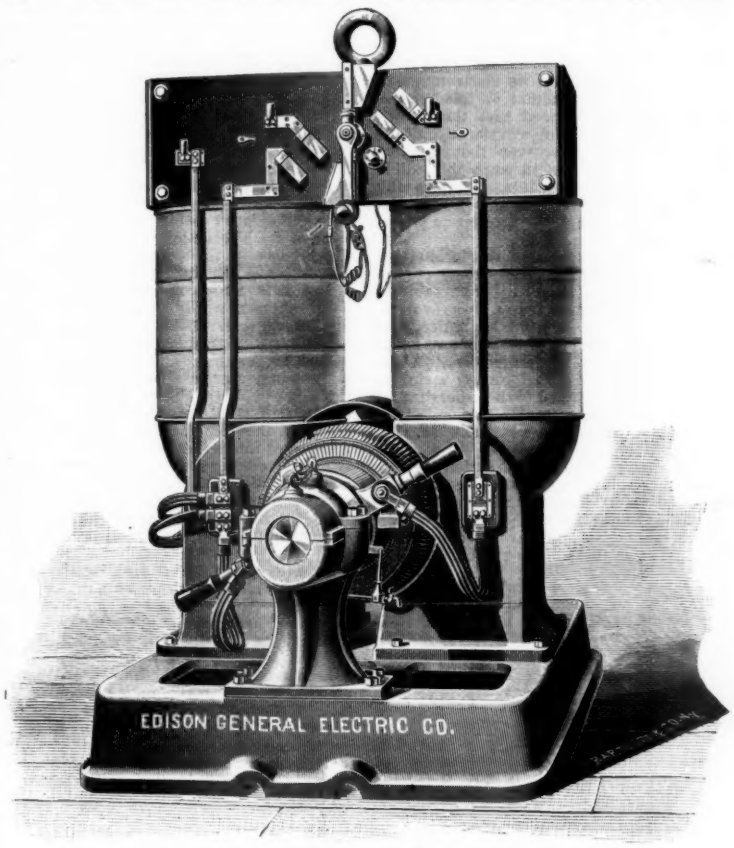
They will now carry their stock largely in the shape of billets which can be hot rolled at a day's notice into whatever width and thickness seems best suited to the demands of their cold rolled sheet steel trade, which, owing to the fine quality of the stock which they are enabled to produce by their secret and patented processes, is rapidly increasing, and they have been for a long time the leaders and largest producers of this class of steel in the world. They have now an annual capacity of about 15,000 to 20,000 tons of steel of all kinds.

Bridgeport is a good field for such a mill, owing to the fact that the bulk of all sheet metal goods are manufactured in the East, and consumers appreciate having their orders filled promptly, and where they can communicate with the mill readily by mail or telephone (local or long distance), and not be subjected to the long delays incidental to dealing with Western mills, especially the delays of transportation. The force of skilled mechanics who have been at work at the hot rolling mill for several years, will enter the employ of The Wilmot and Hobbs Manufacturing Company, and this should, together with the efficient management and close personal attention to every detail for which the officers of this company have for so long been noted, assure to the trade the best possible attention to their wants.

This new acquisition which is already in operation, will probably be known to the trade as The W. and H. Hot Rolling Mill, and will likely be operated on the "department plan."

New Edison Generator.

The elimination of objectionable features from electric lighting and electric power apparatus and the introduction of improvements is the present aim of all manufacturers of electrical devices. In the accompanying cut we present an Edison 200 kilowatt



IMPROVED ELECTRIC GENERATOR.

generator of the latest form illustrating this. It is of the well known bi-polar type, with the general features of which every practical electrician is acquainted. The series field is built up of sections, wound on spools, which are slipped over the cores and then properly connected up. Should a fault manifest itself, it can be located and the spool in which it appears can be removed, repaired and replaced, or another substituted at once without loss of time. Expenditure for repairs is thus reduced to a minimum.

So as to adapt this generator to the demands of electrical railway service, the field has been provided with a compound winding, easily adjusted to meet the necessary requirements by means of a shunt coil, conveniently placed in the back board of the keeper. The bearings being located close to the base frame, the center of gravity of the armature is low and great stability is thus secured. Self-oiling bearings and carbon brushes contribute to diminish the attention necessary to the operation of the generator to a minimum.

A considerable number of these high capacity generators have already been installed by the Edison General Electric Company throughout the country, and the advantages they offer have evidently been appreciated.

Fireflies from Cuba.

Secretary Langley, of the Smithsonian Institution, has been experimenting for some time past with fireflies from Cuba. He says that the light they give is the "cheapest" in the world produced, that is to say, with the least heat and the smallest expenditure of energy; and he believes that a successful imitation of it would prove a most profitable substitute for gas and electricity. The insects are beetles two inches long and belong to the family of "snapping bugs," so called because when one of them is laid on its back it snaps itself into the air with a clicking sound.

The secret of the light this firefly gives is as yet undiscovered. Apparently it is connected in some way with the mysterious phenomena of life, and chemists and physicists have sought in vain to explain its origin. On each side of the animal's thorax is a luminous membranous spot, and these flash at intervals, so that the Cubans put a dozen of the insects in a cage together and so obtain a continuous illumination bright enough to read by. This light is accompanied by no perceptible heat, and is, seemingly, produced with almost no expenditure of energy. How great an improvement it represents upon all known artificial lights can be imagined when it is stated that in candle light, lamp light or gas light, the waste is more than 99 per cent. In other words, if they could be so obtained as not to throw anything away, they would give nearly 100 times the illumination which they do afford.

The Hardening of Magnet Steel.

BY L. HOLBORN.

Samples of different steels were heated in a furnace to various temperatures and hardened in water; they were then magnetized in a coil and the temporary and the permanent magnetism determined; both were greatly affected by the hardening temperature, and the effect of differences in the hardening temperature increased with the increase of carbon in the steels. Each steel had a particular temperature, which gave a maximum permanent magnetism — silver steel, a little below 900 degrees; tungsten steel, 920 degrees, and a third sort, 850 degrees, etc. When quenched at the temperature which gives greatest permanent magnetism, a magnet is no more liable to lose its magnetism from rough usage than when it has been hardened at a higher temperature.

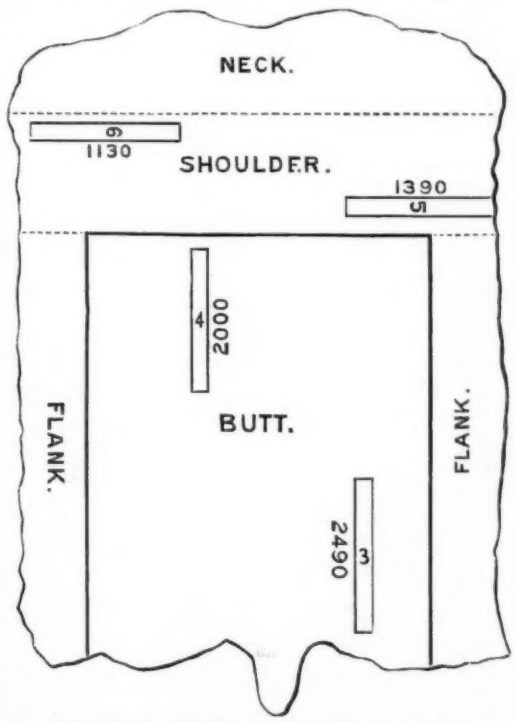
E. S. Nadal describes in the April *Scribner* the "New Parks of the City of New York"—a splendid area of nearly 4,000 acres, which cost the city $9,000,000. The picturesque features of these beautiful parks are plentifully illustrated.

Tanning Leather and Making Belting.

At the meeting of the Polytechnic section of the American Institute, of New York, on Thursday evening, March 17, Mr. Chas. A. Schieren, the well-known belt manufacturer, read a paper on the "Art of Tanning Leather and Making Belting." He showed in the lecture the various processes through which a hide passes in the tannery, which were all interestingly illustrated by lantern slides.

The various departments through which the hide passes in the tannery, the machinery used for manipulating the leather, as well as the grinding and leaching of the bark, were illustrated and thrown on a large canvas by lantern slides. This made the lecture doubly valuable, because the audience could get a clearer idea of the manipulation of leather in the tannery. In the making of belting, Mr. Schieren showed a hide of leather from which were taken four pieces of equal length and width. They had been submitted to a test by a powerful testing machine of the Fairbanks Scale Company, of New York. These pieces were all 18 inches long, and two inches wide, and were numbered. No. 3, being cut from the lower part of the center, broke at 2,490 pounds strain, which would give the piece a transverse strength of 14 940 pounds per square foot. No. 4, cut from the upper part of the center of the hide, broke at 2,000 pounds. No. 5, cut from the lower part of a shoulder piece, broke at 1,390 pounds. No. 6, cut from the upper part of a shoulder, broke at 1,130 pounds.

The lecturer explained that very many belts were sold and offered in the market, which were made from one piece of center on one side, and a piece of shoulder on the other side, and said that such belts were defective, because of the shoulder being so much more liable to stretch, and, not being able to withstand the strain of a center-piece by at least 43 per cent., it would be a serious mistake to put the two pieces together for transmission of power, on account of the unequal tension. A belt would be superior if two shoulders were used, or two center pieces, separately. He claimed that a belt made from two centers could withstand a transverse strain of nearly 26,940 pounds to the square foot, whereas, a belt made from shoulders would hardly stand 15,120 pounds strain, and such belts would not be reliable,



HOW BELTS ARE MADE.—DIAGRAM OF A HIDE.

especially on dynamos, or swift running machinery, in fact, for almost any drive where a belt is subjected to a severe strain.

"Very Handsome Illustrations."

[*Detroit Free Press.*]

The ELECTRICAL REVIEW, published at 13 Park Row, New York, celebrates its tenth anniversary by issuing a very handsome Decennial Number dated February 20, 1892. This issue contains a large number of very handsome illustrations and numerous special articles of more than ordinary merit. A history of electrical progress for the past ten years is an important feature.

Lightning Arresters and the Discovery of Non-Arcing Metals.

BY ALEXANDER J. WURTS, BEFORE THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, NEW YORK, MARCH 15, 1892.

When I first became interested in this subject, I was naturally guided somewhat by previous practice, which had been to provide with each arrester and discharge circuit an automatic circuit interrupter. Fig. 1 illustrates my first practical step in this direction, and represents the Winsor-Wurts lightning arrester, the fundamental idea of which emanated from Mr. Paul Winsor, who proposed that a discharge gap be placed in the neck of a bottle, the idea being that the heat of the arc formed by the short circuit would sufficiently expand the air in the body of the bottle to blow out the arc. With this idea as a nucleus, the arrester depicted in Fig. 1 was evolved. Referring to the figure, it will be noticed, without going into detail, that the arrester is double-pole and that each discharge gap is placed in the center of an air chamber. In the upper part of each of these there is a slotted passage, which might correspond to the neck of a bottle, and in which there is placed a second air gap in series with each of the others. The second air-gap is bridged with a carbon ball, the latter being held in place by tubes having vent holes in the sides and rubber bumpers at the top. The action which takes place when a discharge to ground is made, with a resulting short circuit, is as follows: The arc at either or both of the jumping spaces instantly heats and expands the air in the respective air chamber, which, rushing up through the slotted passages, blows either or both carbon balls to the top of the tubes. The arc formed where the circuit has been broken by the projected carbon ball is, at the same time, instantly blown out, thus completely rupturing the circuit. The only demonstration is a quick puff as the air rushes out of the holes near the upper ends of the tubes. The object of the holes is obvious. As the balls are confined in the tubes they at once drop back to their former positions, and thus automatically place the apparatus in a condition ready for another discharge and short circuit. In testing this arrester the terminals are connected to the circuit of a thousand volt generator. The air spaces are bridged over with a fine wire to take the place of an actual discharge. Then, by the throw of a switch, the full pressure of the machine is placed on the arrester. There is an enormous rush of current, the temporary wire bridges fuse, arcs are formed, the air expands with an explosion, the balls fly up, more arcs are formed, tongues of fire shoot out of the holes in the tubes, the upper arcs are blown out, the balls drop back to their normal positions, and all this happens like a pistol shot, without causing more than an insignificant flicker in the lamps. After short circuiting a thousand volt 3,000 light machine through such an arrester about 400 times, there was not the slightest deterioration to be noticed anywhere.

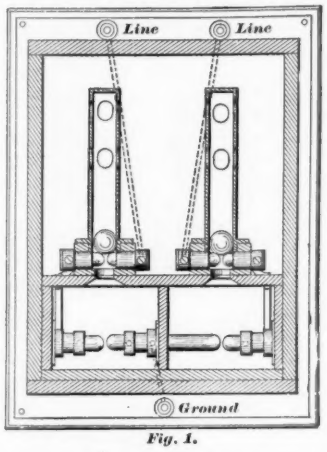


Fig. 1.

Soon after this arrester was completed, steps were taken to adapt the same principle to an arc circuit lightning arrester, which resulted in the one illustrated in Fig. 2. By referring to the figure, you will notice that a vertical solenoid provided with an iron core is connected in the main circuit beyond the point of contact with the discharge circuit. The discharge electrodes are curved arms which swing freely through the sides of a cylindrical air chamber, and the construction is such that when the core falls, the discharge electrodes will be forced out. The action is then as follows: Under normal running conditions the core is held up in the solenoid, but if a discharge occurs from both sides at once, short circuiting the machine through the discharge points, the solenoid will at once lose its power, the core will fall and force the discharge arms out through the holes in the walls of the chamber. This action would draw out arcs three inches long, and the heat thus generated is sufficient to cause a sudden expansion of air in the air chamber and thus blow out the arcs, even though the current be but 10 amperes and the pressure 3,000 volts. Without the device just described for lengthening the arc, the heat developed would have been insufficient. In short circuiting a 50 light machine through this arrester, there is a scarcely perceptible flicker in the lamps, the core drops, the short circuit is opened and the core drawn back into its normal position ready for further action, all in an instant of time. Although I have used an electromagnetic device in the construction of this type of arrester, it will be noticed that the placing of a coil in the lightning arrester circuit has been avoided, so that even though every discharge has to pass through this coil to reach the discharge points, yet, from this point on, the discharge has a non-inductive path to earth through the arrester in preference to the dynamo.

Neither of these arresters would interrupt a short circuit on a 500 volt direct current generator, so, after some further experimenting, the arrester shown in Fig. 3 was evolved. Referring to Fig. 3, it will be noticed that there are two air chambers, in each of which is a fixed carbon discharge point. Above these chambers is a curved carbon swinging freely from one chamber to the other through suitable openings, so that either end of the curved carbon, as the case may be, shall come into close proximity to either of the fixed discharge points. The action is as follows: When a discharge takes place, it passes to one of the fixed discharge points, depending upon the position of the curved carbon, then across the air space to the curved carbon, and from there to the ground, as shown

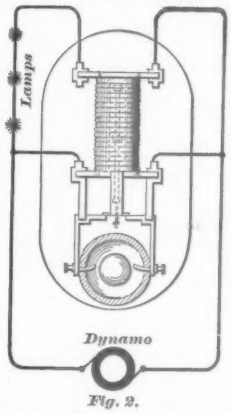


Fig. 2.

in the figure. The dynamo current then following causes an arc to be established between the curved carbon and one of the fixed points, and the heat generated by this arc expands the air in its respective chamber, increasing the pressure therein, and causing the curved carbon to be instantly blown from one chamber to the other. This ruptures the arc and adjusts the arrester for the next discharge. In testing this arrester, 500 volt and 1,000 volt generators have been repeatedly short circuited through it, and in every case the circuit has been instantly broken without injury to the dynamo, and the arrester has as quickly reset itself in readiness for future use. In one of the tests made to demonstrate its promptness and reliability, the fixed points were so adjusted as to touch the curved carbon in either of its two normal positions. A 1,000 volt generator was then short circuited through the arrester, which resulted in the circuit being repeatedly opened and closed without injury to either dynamo or arrester. This power circuit arrester was afterwards much improved, and finally took the form shown in Fig. 4, and the arrester shown in Fig. 1 was also finally changed to this form. This arrester is made of iron and marble, and its advantages over the others are its non-combustibility and the double break in connection with the air blast. Fig. 5 illustrates the same arrester fitted into an iron box lined with asbestos, and in this shape is adapted to either car or pole use.

With the idea of gradual charging in mind, the following plan was hit upon for a lightning arrester. The first conception was to alternately ground both poles of a generator over a very small air gap and at rapidly recurring intervals. The improved plan, however, was to alternately dead ground the poles of an alternator at every neutral point in the electromotive force wave, the idea being to so constantly discharge the line in this manner as to effectually prevent a charge from attaining any considerable intensity, and at the same time avoid the short circuit which now invariably follows the discharge over the air gap of our present arresters. The method of carrying out this plan will be understood by a glance at Fig. 6. Upon experimenting, I found that an alternator could be short circuited at the neutral point without a spark. If the short circuit occurred a little before the neutral point, that is, on a decreasing electromotive force, there was slight sparking, but no tendency to hold on. If the short circuit occurred at all after the neutral point a furious arc was established, which would hold on indefinitely.

This form of arrester has not yet been tested in actual practice. It is only adapted to alternators.

For direct current use I have devised something quite similar, the principle of which will be understood by reference to Fig. 7. Referring to the figure, A is a generator, one pole of which is grounded at G, the other being connected to the trolley line L; E is a circuit controling device consisting of fixed commutator-like metal pieces e^1, e^2, e^3, opposite pieces being electrically connected; F^1, F^2 are brushes insulated from each other and revolving at a high speed in a direction indicated by the arrow, F^1 is connected to earth and F^2 to the line; e^1, e^2, e^3 are connected, respectively, to three condensers, C^1, C^2, C^3, the latter being grounded as indicated at *d*. The action is as follows: With the brushes in their present positions, the line is connected through F^2 and e^3 to condenser C^2. This condenser is, therefore, being charged while condenser C^1 is being discharged to earth through e^1, F^1. When F^2 passes to e^1, condenser C^1 will be connected to the line, and become charged, while condenser C^2 will be discharging through e^2 and F^1. Thus, by the continued rotation of these two brushes, it will be seen that the trolley line is being constantly discharged into a fresh condenser.

This arrester has also not been tested in actual practice, but, if my hopes are fulfilled, it will accomplish for direct current circuits what the neutral point arrester is intended to accomplish for alternating circuits, the idea being in either case to take off the charge bit by bit, but at such rapidly recurring intervals that the line will be kept practically free from charge, or at least prevent the charge from obtaining sufficient intensity to damage any portion of the system.

Let me call your attention to an experiment which I am confident is not old in detail. Referring to Fig. 8, L is a Leyden jar, *l* is a bare line wire, a portion of which is coiled and immersed in a tank K of water. This tank is well grounded. Line *l* is continued through induction coil C and then grounded as shown; *b* is a gap discharge circuit. Now, with a spark at A there was a small spark at *b*; with a gap at *d* there was sparking at *d* and *b*, spark *d* being larger than *b*. With a gap at *e* sparks were obtained simultaneously at *d*, *b* and *e*. Induction coil C was either a primary or a secondary of a 40 light converter. When C was primary, spark *e* was very small. When C was secondary, *e* was larger, but still small when compared with *d* and *b*. From these experiments I learned two lessons, both of

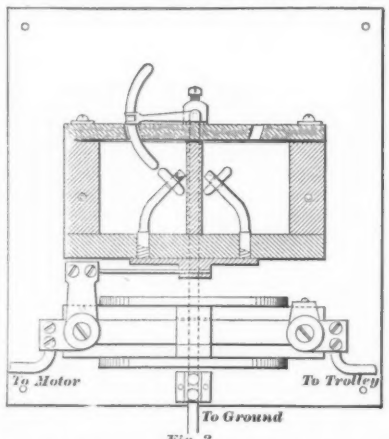


Fig. 3.

them old, but in books they did not impress me as they did in practice. The first lesson was, that I must not expect one or two discharge circuits to discharge the many miles of wire that we have in our lighting and power circuits. The second was that a "kicking coil," no matter how great its impedance, would still take a portion of the discharge. My final conclusions then were that, in order to afford the best possible protection for electric plants, the wires must fairly bristle with discharge points properly located in discharge circuits. With this idea in mind a cheap and effective pole arrester seemed to be the proper thing to look for. My experiments from this time on led me to a discovery so remarkable, and so contrary to all previous ideas, that I am going to read you a description of them.

In designing the arresters already described, I had followed closely the rut of previous practice, which had always been to provide with each discharge circuit a circuit interrupting device. Upon reflection, however, it was evident that one circuit interrupter placed in the main circuit would interrupt the arc on any discharge circuit. For a moment the problem of a simple pole arrester seemed solved, but on second thought the difficulties and inconveniences inseparable from any automatic main circuit interrupter appeared to be insurmountable, and the idea was no sooner conceived than it was abandoned. And yet, poor as it was for practical purposes, it proved a good stepping stone, and led to the following plan, viz.: To provide the line with ordinary discharge circuits, that is, with the well known saw-tooth protectors, made of carbon so that they would not easily burn away; and then in the station, between the generator and the first discharge circuit, provide an automatic device which, upon the passage of an abnormal current from the generator, would instantly short circuit the dynamo and as quickly open again, the intention being that should a short circuit occur out on the line through any of the discharge circuits, a short circuit at the dynamo would so reduce the pressure on the line as to render it impossible for an arc to maintain itself. Then, any such arc having been extinguished, the short circuit at the generator could be interrupted, and the service would continue as before. This idea meeting with general approval, steps were at once taken to put it to a test in the following manner: To a 1,000 volt alternator there was connected a circuit consisting of about 100 yards of line wire, and in this circuit there was placed a pair of carbon dischargers having saw-tooth edges, and a $\frac{1}{16}$ inch air gap, also a switch. In shunt with this circuit, that is, directly across the terminals of the generator, there was connected a simple device (it will not be necessary to explain its construction) which, upon the passage of an abnormal current in the circuit containing the dischargers, would instantly short circuit the generator and as quickly open again. All the connections being made, the air gap was bridged with a bit of tinfoil to start the arc, and the switch thrown. The actions that followed in an inconceivably short space of time were these: The tinfoil burst with a snap, an arc was formed, the automatic short circuiting device operated, the arc was extinguished and the short circuiting device opened. So far, this was exactly what was anticipated, but no sooner had the short circuiting device opened, and the electromotive force returned to the line and the dischargers, than the dynamo pressure forced an arc across the air gap once more, and the whole operation was repeated. This repetition was found to be due to the fact that when the arc was first established between the carbon saw-tooth plates, the carbons were heated to a white heat which, not having time to dissipate itself before the pressure returned, the dynamo current found a sufficiently easy path over the heated air gap to re-establish an arc. However, the test being otherwise satisfactory, success seemed assured, for all that was necessary now was to use solid metal dischargers that would readily conduct the heat away, and the trouble above cited would, no doubt, be avoided. So the test was repeated, using the same apparatus as before, except the dischargers, which now consisted of three solid, round, brass rods, 1 inch in diameter and $1\frac{1}{4}$ inch long, placed side by side, with their axes parallel to each other, and having air gaps of $\frac{1}{16}$ inch. That is, the line was connected to the two outside bars, leaving the middle one idle to be connected to ground, as would be the case in a double pole lightning arrester. The air gaps were bridged as before with tinfoil to start the arc, and the switch thrown. The test was successful in the highest degree—too successful, in fact, not to arouse suspicion. So I thought I would repeat the experiment, and see how the dischargers would behave without the short circuiting device. The result was an overwhelming surprise, for at the dischargers there was merely an insignificant spark, scarcely larger than a pea. The experiment was tried again and again, with the same result. Any electrician would have predicted a brilliant display of fireworks. The most

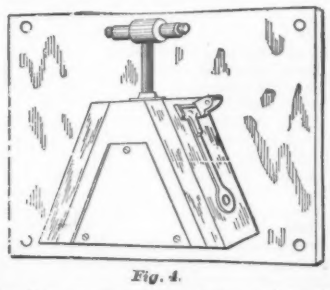


Fig. 4.

plausible theory advanced to explain this action was that, the electric motor driving the dynamo being small, its speed was probably reduced to such an extent by the overload suddenly thrown upon it that the electric pressure was at once reduced below that which would be necessary to maintain an arc across the air gaps. On second thought, this theory would have seemed improbable, but at the time it was accepted without a question. In a few days a test was again made, this time a small engine being used for motive power, and the same

results were obtained as before. The afternoon of the same day both engine and generator were changed, with like results. In the meantime a little reflection seemed to indicate that perhaps this strange action was not, after all, due to the slowing down of the motor, but to the possible cooling effect of the metal dischargers on the arc. With this idea in mind, I had constructed a set of three dischargers similar to the first, but much larger, 2½ inches diameter by three inches long, thinking that if a little metal

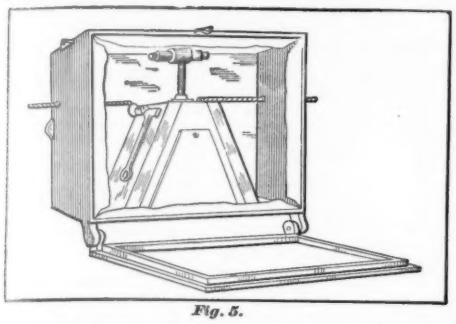


Fig. 5.

was good, more would be better, and that perhaps with a large generator the mass of metal would have to be greatly increased to produce the results already obtained. This large discharger was connected to a 3,000 light, 1,000 volt alternator; the air spaces were bridged as before; and the scene which followed beggars description. The large metal bars were melted like beeswax in a great ball of fire. My disappointment was keen, for I thought I was on the verge of making a discovery, and that in the previous cases the comparatively feeble engine had not been the cause of the action. Thinking, however, there could be no harm in melting up the smaller discharger, I connected it in where the larger one had been, bridged the air space, and threw in the switch. Imagine my astonishment on hearing an insignificant snap like the crack of a toy pistol, and seeing an arc as before no larger than a pea. I then pushed a nickel down into one of the air gaps to short circuit it, and leave only one air gap for the arc, and tested again, with the same results. Two questions now presented themselves, viz., what were the differences between the large and small dischargers other than size, and why did the small discharger behave in this altogether unlooked for manner? The answer to the first question was readily found by tracing the two dischargers back to their source, and there learning that the larger one of the two was made of cast brass, containing certain proportions of tin and copper, and that the smaller one was made of hard drawn brass, containing certain proportions of zinc and copper. These facts at once established two differences between the dischargers other than mere size: One was their physical structure, the other their composition. Which of these two differences caused the difference in their actions? A discharger composed of cast brass, containing the same proportions of zinc and copper as the hard drawn brass discharger, was made and tested and found to work perfectly. It was thus determined that the physical structure of the metal had no influence in suppressing the arc. The important difference between the two dischargers then lay probably in their composition, and I was now rapidly becoming convinced that in brass, consisting of certain proportions of copper and zinc, there must exist certain properties which do not permit of an arc being maintained between two dischargers, even with the high pressures of 1,000 volts. It also occurred to me that possibly the shape of the dischargers had something to do with the results obtained. So the next step taken was to have a number

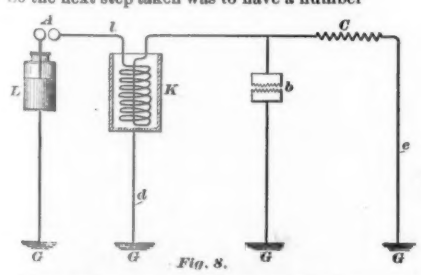


Fig. 8.

of dischargers made up in different shapes and sizes, such as spheres, ovals, solid half cylinders, tubes and cubes. All worked well with the exception of the cubes. The cubes were placed so their faces were separated by $\frac{1}{16}$ of an inch. Now, when the tinfoil was placed over their edges, the action was favorable, but if the tinfoil were pushed down between the faces, the arc would hold on indefinitely, and yet without any demonstration whatever, thus, even when the arc did hold on, showing a very different action from the other metals. The size of the dischargers did not seem to affect the results so long as there was sufficient metal to prevent actual melting—

$\frac{1}{4}$ inch brass rod melted on the third trial. It was next decided to make dischargers of other metals, and thus learn whether there were any other substances that would give these results, and if so, perhaps some light would be thrown on the real cause of the action. The metals first tested were hard steel, hard drawn copper, phosphor bronze, aluminium bronze and aluminium, all of which failed utterly. The next metal tested was zinc, and with this most successful results were obtained. Perhaps you will now think the experimenter very slow to put two and two together, but who is there who is at all familiar with the properties of zinc, that would have suggested this metal as one likely to resist an electric arc and 1,000 volts in this manner? With such results before me, I was ready to try anything. The next metals were tin and nickel. Both of these failed. Tin made the most brilliant display of all the metals. The next tried was antimony, and it worked perfectly. The theory now advanced to explain the phenomena was that, with the metals that do not allow the arc to be maintained, there is formed, at the instant the arc is started, an oxide of the metal which, becoming instantly volatilized in the intense heat of the arc, chokes up the air gap with vapors of high resistance, and so presents an effective barrier to the further passage of the current. With metals that do maintain the arc, instead of the vapor of the oxide of the metal, there is formed a pure vapor of the metal itself, and this offers comparatively no resistance to the passage of the current. When tests similar to the above were made on a 500 volt direct current generator, every one of the metals failed. The arc, however, was small and quiet with the special metals, thus even with the direct current showing a very peculiar action.

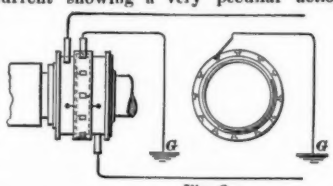


Fig. 6.

Another curious phenomenon connected with zinc and antimony is this: The smaller the air gap the less tendency there is to maintain an arc when using an alternating current at 1,000 volts pressure. In fact, when the air gap is two inches long the arc, when once started, will be maintained, while at one-half inch or one-quarter inch the arc will not give up without a struggle, and at $\frac{1}{32}$ inch there is only a small spark caused by the fusing of the tinfoil, and the circuit is instantly interrupted.

The next step taken was to try higher pressures. A short circuit on a 2,000 volt generator, through the double air gap discharger, failed to be interrupted; four and five air spaces also failed. Six air spaces of $\frac{1}{32}$ inch each, interrupted the short circuit instantly, but six air spaces, which would make three on each side of the circuit for the lightning charge to jump through, were strongly objected to as offering too great a resistance. A test was then made to determine the pressure needed to strike an arc across three air gaps, and was found to be 3,500 volts, measured with a Cardew on an alternating current generator. The experimenter then procured a lightning arrester well known in the market, and one which is known to take the lightning discharge successfully, and tested it for the striking electromotive force, which was found to be between 8,600 and 9,000 volts. In order, however, to avoid any prejudice that a series of air gaps might arouse, the following plan was hit upon: Pairs of non-arcing dischargers were mounted upon thermostatic supports in such a manner that the pairs would

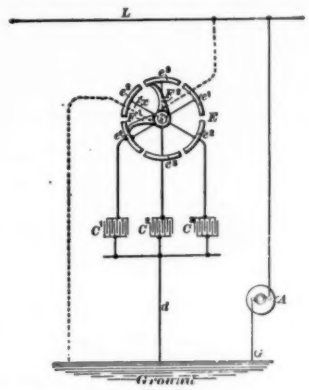


Fig. 7.

normally rest in contact with each other, and so that any current traversing the system would be forced to pass through the thermostats and dischargers in series. The thermostats were so arranged as to cause the two dischargers in each pair to open a way from each other upon the passage of the current. If, then, a single and permanent air gap were connected in series with this system, that is, an air gap just sufficient to prevent the normal pressure of the line from striking any arc, and if an arc were started across it, the sudden rush of current through the thermostats would instantly introduce a number of air gaps in the circuit corresponding to the number of pairs of thermostatic dischargers, and thus automatically open the short circuit. This device was tested and found to work admirably. Of course, after the circuit has been interrupted, the thermostatic dischargers at once return to their normal positions. In fact, this action is so rapid that if a series of these dischargers be connected in a short circuit without a permanent air gap, the circuit will be automatically opened and closed every two or three seconds. In order to appreciate the very remarkable action of this thermostatic device, it must be well borne in mind that a very small air gap is all that is necessary for the interruption of the circuit.

Thus far, although I had tested a number of metals, my selection had been quite at random, so that by this time I was desirous of making a more thorough and systematic investigation of this new property. The chemical properties of zinc and antimony were carefully compared without any new light. The various groups of metals were examined, and then it occurred to me that, of all the metals tested, not one of them belonged to the two groups in which zinc and antimony are found according to Mendelejeff's grouping. The metals of the zinc group are zinc, cadmium, mercury and magnesium; and of the antimony group are antimony, bismuth, phosphorus and arsenic. I first tested cadmium and found it non-arcing. Then magnesium—more, however, from a sense of duty than because I had hopes of anything but negative results. Fortunately, I made this test on much lower electromotive forces, and found it non-arcing at 100 volts over two air gaps of $\frac{1}{32}$ inch each. On 250 volts the magnesium caught fire, which was, of course, anticipated. I then wanted to try mercury, but, for the moment, not seeing how to make such a test with a liquid, I was diverted to the antimony group, and upon testing bismuth found it to be non-arcing. Phosphorus and arsenic were not tested. A final attack was now made upon the zinc group by testing mercury in the form of a copper amalgam. This test was the most successful one of all, for after a number of short circuits on a 1,000 volt alternator, I found the surface of my dischargers had not been disturbed in the slightest degree. It will thus be seen that all available metals in these two groups are non-arcing. In searching for the non-arcing metals, each test was made with two air gaps, and the electromotive force at the time of the short circuit was, with the exception of the test on magnesium, 1,000 volts.

Fig. 9 represents a double pole lightning arrester made of non-arcing metal, and, in connection with this paper, will be readily understood without further explanation.

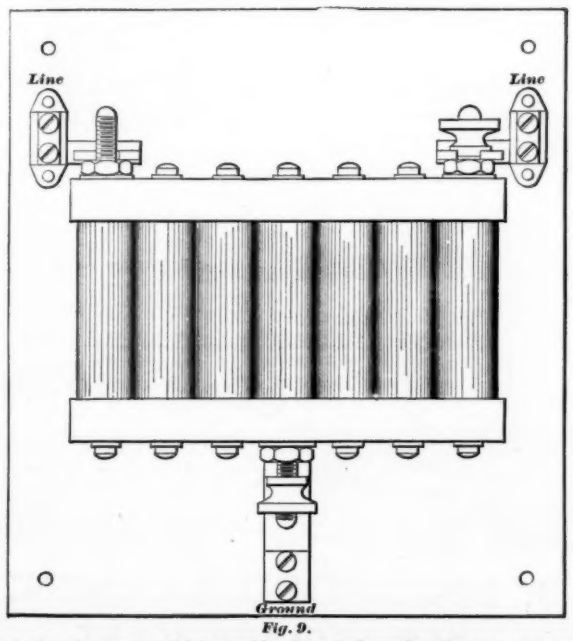


Fig. 9.

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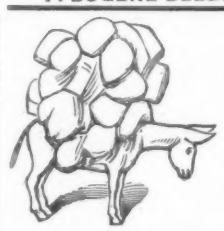

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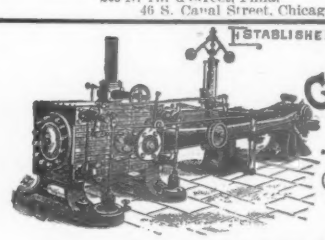

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ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENTS OF THE UNITED STATES WERE ISSUED ON MARCH 9, 1892.

470,654 Electric railway; Edward M. Bentley, Boston, Mass.

470,656 Motor for electric cars. 470,657 Contact device for electric railways; Francis O. Blackwell, Boston, Mass., assignor to the Thomson-Houston Electric Co. of Connecticut.

470,666 Police and fire alarm signaling apparatus; Leroy B. Firman, Chicago, Ill.

470,667 Combined police and fire alarm signal apparatus; Leroy B. Firman, Chicago, Ill., assignor to the Police Telephone and Signal Co., same place.

470,697 Protector for electrical apparatus; Chas. H. Morse, Cambridge, Mass.

470,701 Secondary battery; George F. Parker and Chas. E. Crapo, Rochester, N. Y., assignor of one-half to Edwin S. Hayward, Jr., same place.

470,721 Lightning arrester; Elihu Thomson, Lynn, Mass., assignor to the Thomson-Houston Electric Co. of Connecticut.

470,722 Tell-tale device for electric circuits; Edgar Tregoning, Malden, Mass., assignor of one-half to Alvin E. Bliss, same place.

470,736 Lightning arrester; George M. Bacon, Scranton, Pa.

470,748 Electric switch; Samuel Deacon, Lynn, Mass., assignor to the Thomson-Houston Electric Co. of Connecticut.

470,749 Field magnet for dynamos; George E. Dorman, Chicago, Ill., assignor to the Standard Electric Co., of Illinois.

470,752 Electrical hose signaling apparatus; Wm. Fowler, Colorado Springs, Colo.

470,766 Arc light hanger; Charles A. Pfluger, Chicago, Ill., assignor, by direct and mesne assignments, to the Standard Electric Co., of Illinois.

470,768 Printing telegraph; Edward J. Silkman, Baltimore, Md., assignor of two-thirds to George D. Penniman and Thomas K. Worthington, same place.

470,772 470,773 Circuit interrupting device. 470,774 Apparatus for protecting circuits; Alexander Wurts, Pittsburgh, Pa., assignor to the Westinghouse Electric and Manufacturing Co., same place.

470,784 470,785 Dynamo; William H. Elkins, Cambridge, Mass.

470,786 Appointment signal for telephones; Lilas W. Gray, Fort Dodge, Iowa.

470,790 Electric switch; Hugh Moore and Oliver O. Jarrard, Mauch Chunk, Pa.

470,792 Galvanic battery; Francis H. Root, Chicago, Ill.

470,798 Switch for electric signaling apparatus; Leopold Sellner, Vienna, Austria-Hungary.

470,806 Railroad circuit closer; Frank E. Kinsman, Plainfield, N. J.

470,810 Employé's time recorder; William Lucas and Thomas A. Garrett, London, England.

470,813 Electric railway signal; Adoniram J. Wilson, Port Chester, N. Y., assignor to the Hall Signal Co., of Maine.

470,816 Time indicator and alarm; Henry Bennett, Middleton, St. George, assignor to Stephen Alderson, Leeds, England.

470,817 Electric railway motor. 470,844 Electric wire support; Francis O. Blackwell, New York, N. Y., assignor to the Thomson-Houston Electric Co. of Connecticut.

470,820 Electric connector; William H. Garland, Chelsea, Mass., assignor to the Thomson-Houston Electric Co. of Connecticut.

470,821 Railway time signal; Henry Gosman, Watertown, N. Y.

470,831 Annunciator; Archibald H. Brintnell, Toronto, Canada.

470,865 Transmission of electrical energy to a distance; Marcel Deprez and Jules Carpentier, Paris, France; said Carpentier assignor to said Deprez.

470,883 Insulation for electric wires; Samuel Vanstone, Providence, R. I., assignor to himself and Frederick A. Fairbrother, Jr., same place.

470,922 Manufacture of filaments for incandescent lamps; Thomas A. Edison, Menlo Park, N. J.

470,923 Railway signaling. 470,924 Electric conductor. 470,925 Manufacture of filaments for incandescent electric lamps. 470,926 Dynamo-electric machine or motor. 470,927 Driving mechanism for cars. 470,928 Alternating current generator. 470,929 Magnetic separator. 470,930 Dynamo-electric machine; Thomas A. Edison, Llewellyn Park, N. J.

470,946 Underground electric conduit; James F. Munsie, Jersey City, N. J., assignor to Thomas Leonard Coles, New York, N. Y.

470,994 Contact maker; Daniel Draper, Hastings-on-Hudson, N. Y.

471,053 Electric actuated rending machine; Archie J. Henry, Watertown, N. Y., assignor of five-eighths to Ernest A. E. Meyer, Charles H. Sprague and James B. Wise, same place.

471,063 471,064 Electric elevator; Randolph C. Smith, Yonkers, N. Y., assignor, by mesne assignments, to the National Co., Chicago, Ill.

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